ILLUMINATING ENGINEERING

DECEMBER 1950

Industrial Fluorescent Luminaire Calculations
Fluorescent Lighting in the Home—Part I
Brightness Ratios and Visual Performance
General Secretary's Report for the Year
Evaluating Fluorescent Luminaires
Light for Aircraft Inspection

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

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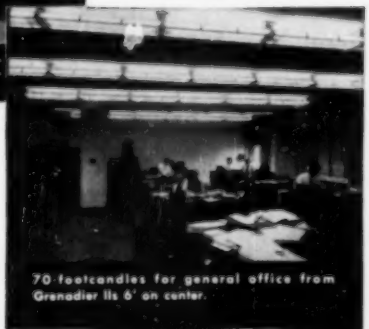

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ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

DECEMBER 1950

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Bulb diameter	1½"	1½"
Lamp Length	24"	48"
Base	Medium Bipin	Medium Bipin
List Price	$4.50	$7.00

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Effect of Task-to-Surround Brightness Ratios on Visual Performance

By R. L. BIESELE, JR.

This paper is a report on the findings of I.E.S. Research Fund Project #18, The Effect of Task-to-Surround Brightness Ratios on Visual Performance. The project is a pilot project only, to determine if significant results can be obtained by the method. The results reported here indicate that the task-to-surround brightness ratio may be fully as significant a factor in visual performance as the illumination level.

FOR SOME TIME, it has been apparent that the brightness ratio of the visual task to its surround had a definite effect on the comfort of persons doing moderately difficult visual work. It appeared desirable to investigate the possibility that this task-to-surround brightness ratio might also affect the rate at which this visual task could be performed. Consequently, a grant was obtained from the I.E.S. Research Fund to investigate a method by which quantitative measurements of this effect might be obtained.

The general plan of this pilot project has been to investigate the effect of various ratios of task brightness to surround brightness on the rate of distinguishing the orientation of the gaps in a set of Landolt rings. This technique was borrowed from the British work of Weston and others, as it represented a performance task closely related to typical work situations. The project has consisted of a group of pilot experiments only, to determine whether significant data can be obtained by these methods.

The Visual Task

The visual task employed was a set of cards on which was printed a pattern of Landolt rings as used in the British tests. The pattern is reproduced full size in Fig. 1, and was printed in the center of a sheet eight and one-half inches square. The task is black ink (8 per cent reflectance) on white paper (78 per cent reflectance), and the significant detail, the gap in the ring, is three minutes visual angle when the chart is viewed from 14 inches.

The three-minute visual task was chosen for these tests because it was above the threshold of visual size, yet represented at the same time a visual task sufficiently difficult that the rate of marking would be affected significantly by the changes in brightness ratios. The task was at approximately the midpoint of the British tests on the significance of visual size.

Test Cubicle

A test cubicle similar to that used by the British was employed. It consisted of a plywood enclosure four feet square by eight feet high with one side open. The walls of the cubicle are painted flat white. Built into this cubicle is a table four feet square and 30 inches high. The table top is of opal glass, which can be lighted uniformly from below by a group of lights controlled by a dimmer. Thus the brightness of the table surface can be varied. Additional overhead lights, also dimmer-controlled, assist in illuminating the cubicle walls to produce a uniform brightness in the visual field.

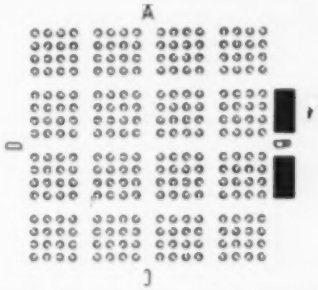


Figure 1. The visual task employed in the project, reproduced full size.

A separately controlled projector lights the visual task. Consequently the brightness of the visual task and the visual field can be controlled independently. With the task brightness held constant at 20 footlamberts, the ratio of task-to-surround brightness can be varied from 1:1/20 to 1:10.

Test Procedure 1 — Test with Eyes Rested

This test procedure was designed to eliminate as nearly as possible the effect of visual fatigue. The

A paper presented at the National Technical Conference of the Illuminating Engineering Society, Pasadena, California, August 21-24, 1950. Author: Professor and Head, Dept. of Electrical Engineering, Southern Methodist University, Dallas, Texas.

subject was first shown a copy of the test chart, and was informed that he was to mark all circles with the gap oriented in a specified direction, as rapidly as possible without errors. The subject was then instructed to rest with his eyes closed for a period of five minutes.

Following these preliminaries, the test proceeded in five-minute intervals as follows. First, with a dummy test in position, the subject was allowed

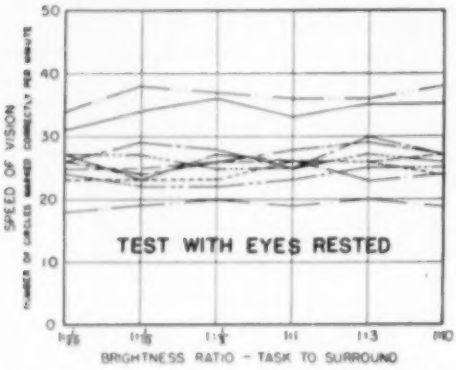


Figure 2. Results of short time test with eyes rested for ten observers. No significant change is produced by change in brightness ratios.

to adapt for one minute to the brightness pattern presented. Second, he was presented the actual test, and tested for one minute. Third, he was permitted to rest with eyes closed for three minutes before repeating the test at another brightness ratio.

The full test ran for one hour, and the task for all tests was held at 20 footlamberts brightness. First and last tests, and one in the middle, were at a brightness ratio of 1:1,' task-to-surround. The other tests were made in a pre-determined random pattern which was repeated in reverse order during the second half hour to balance out any fatigue effect.

Fig. 2 shows the results of this test in terms of the number of circles marked correctly per minute, versus the brightness ratio of task-to-surround. It will be noted that the rate for each observer remained essentially constant regardless of the brightness ratio, as did the average, mean, and modal rates for the group of ten observers. The performance on this test was apparently not affected by the brightness ratio, for these observers, with eyes rested.

Test Procedure 2 — One-Hour Fatigue Test

The second test procedure was designed to determine whether any significant difference in fatigue effect could be found for different brightness ratios over a period of one hour. Therefore, for all tests in Procedure 2, the task brightness was held at 20 footlamberts as before, but the brightness ratio was also held constant for the entire hour. The subject was provided with a technical book, of comparable visual difficulty, on a topic with which he was familiar, and read this book under the same brightness conditions as the test during the time he was not being tested. He first rested with eyes shut for five minutes, adapted for one minute, tested for one minute, read for nine minutes, tested for one minute, read for nine, and so on for the balance of the hour. The subjects were tested for other brightness ratios on successive days. Fig. 3, a-f, shows the data obtained for four observers.

It will be noted that, contrary to expectation, and contrary also to the subjective evaluation of the task difficulty as reported by the subjects, no significant fatigue effect can be observed, regardless of the brightness ratio. Instead, for each brightness ratio, the speed of vision increased throughout the hour. Apparently the brightness ratios either did not produce fatigue over this test period, or the subjects were able to over-compensate for whatever fatigue effects the brightness ratios may have introduced.

Test Procedure 3 — Four-Hour Fatigue Test

Discussion of the test results for Procedures 1 and 2 with persons qualified in Experimental Psychology and Physiology indicated that the results obtained were what could have been expected. A third test procedure was suggested as possibly more indicative of the relative severity of the task.

The procedure for this third test was essentially the same as for the one-hour fatigue test, but differed in two important respects. First, the test period was extended to four hours. Second, the subject was required to mark test sheets throughout the four-hour period. The subject was timed at ten-minute intervals. This procedure eliminated some of the psychological stimulus which was probably present in the first two procedures. Tests were given on alternate days to allow for recuperation between tests.

Results for two observers are shown for this test procedure in Fig. 4, a-f. As in Procedure 2, the performance trend is upward for all brightness ratios for the first hour. Thereafter, however, the trend is downward for both observers for the ratios 1:1/20, 1:1/10, and 1:10. The trend is essentially level for the other three ratios tested, during the last three hours of the tests. The subjects reported considerable visual and bodily fatigue for all the tests, but were particularly bitter about the

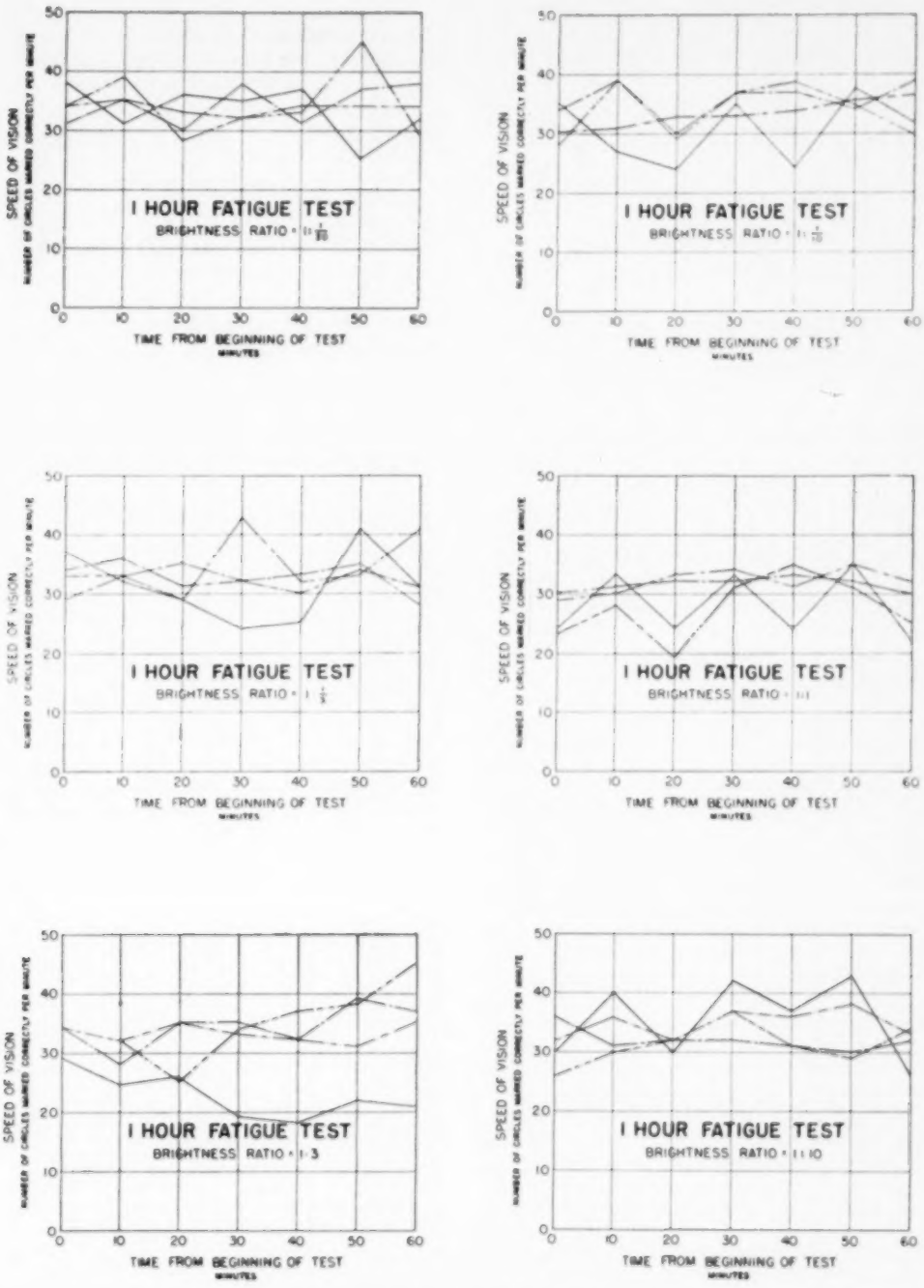

SPEED OF VISION
I HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1:1/10
TIME FROM BEGINNING OF TEST
I HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1:1/10
TIME FROM BEGINNING OF TEST
I HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1:1/3
TIME FROM BEGINNING OF TEST
I HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1:1
TIME FROM BEGINNING OF TEST
I HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1:3
TIME FROM BEGINNING OF TEST
I HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1:10
TIME FROM BEGINNING OF TEST

Figure 3. Results of one-hour fatigue test for four observers. Fatigue effect is either not present, or is overcompensated by subjects.

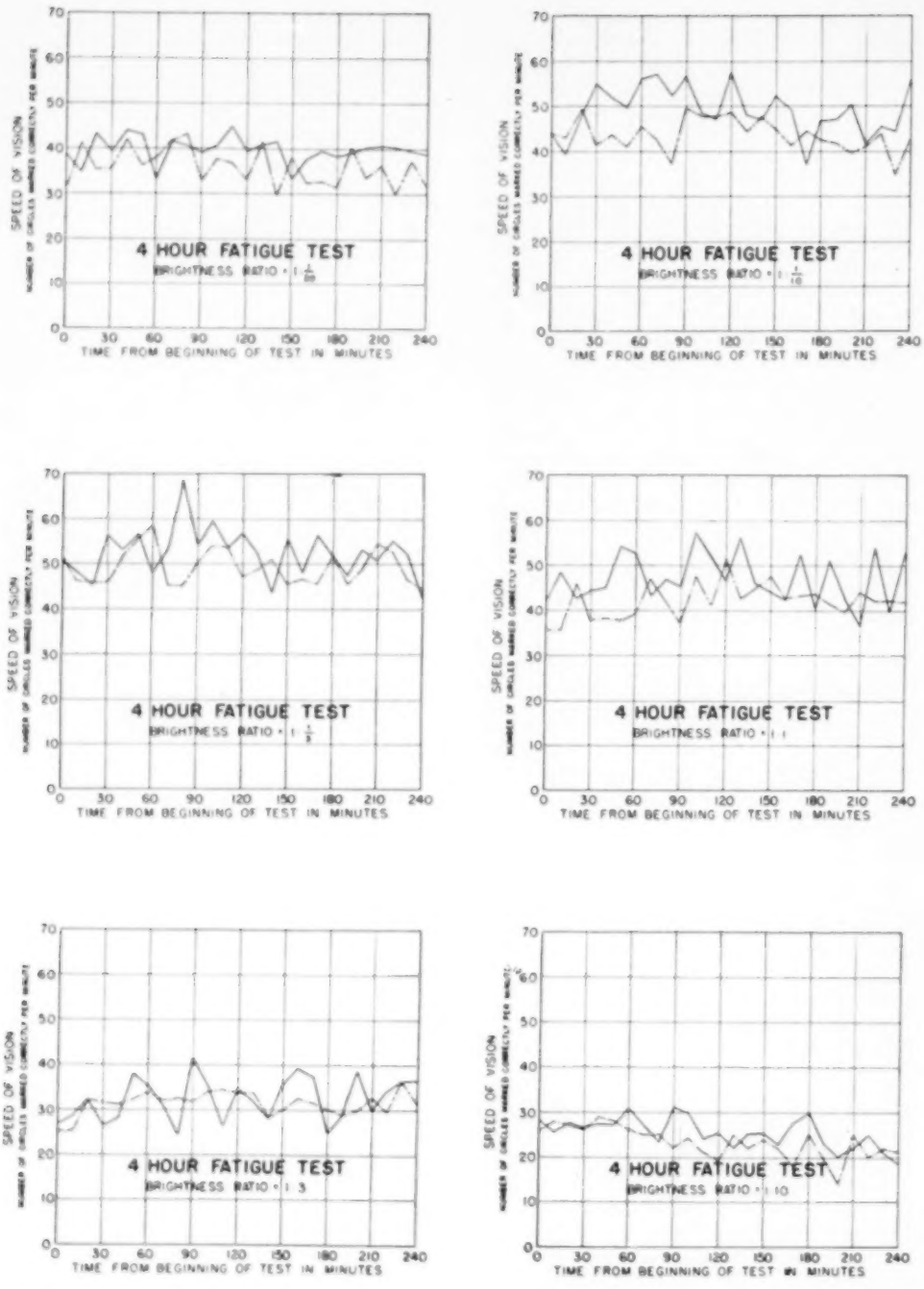

SPEED OF VISION
4 HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1 : 1/20
TIME FROM BEGINNING OF TEST IN MINUTES
SPEED OF VISION
4 HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1 : 1/10
TIME FROM BEGINNING OF TEST IN MINUTES
SPEED OF VISION
4 HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1 : 1/3
TIME FROM BEGINNING OF TEST IN MINUTES
SPEED OF VISION
4 HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1 : 1
TIME FROM BEGINNING OF TEST IN MINUTES
SPEED OF VISION
4 HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1 : 3
TIME FROM BEGINNING OF TEST IN MINUTES
SPEED OF VISION
4 HOUR FATIGUE TEST
BRIGHTNESS RATIO = 1 : 10
TIME FROM BEGINNING OF TEST IN MINUTES

Figure 4. Results of four-hour fatigue test for two observers. Fatigue effect noticeable during the last three hours for ratios 1:1/20, 1:1/10, and 1:10.

severity of the 1:10 ratio, which was described as "brutal." They volunteered also a belief that their performance on the tests would not reflect the actual fatigue which they experienced.

The average rate of marking over the four-hour period is shown in Fig. 5. The pronounced differences indicated on this chart show that the effect of the brightness ratios of task-to-surround are of major significance. Admittedly, two is far too few observers on which to base any conclusions, even when the observers check as closely as did these two. However, differences of the order of two to one are not often encountered in the literature pertaining to light and visual performance.

The data of this test justifies considerable further investigation into the effect of task-to-surround brightness ratios on visual performance. *If this data is confirmed, it means that the task-to-surround brightness ratio is at least as important to visual performance as is the illumination level.*

Test Procedure 4 — Changing Brightness

In the light of the rather great differences found in the performance of the individual subjects even over a few minutes, as well as of the differences between observers, a fourth rather simple procedure was tried. This fourth test would give data which could be compared with the generally accepted data on the effect of increase in illumination on visual performance. The results are quite interesting.

A test procedure similar to Procedure 1 was employed, except that the brightness ratio of task-to-surround was held at 1:1, and the brightness level was varied over the range of 1 to 100 footlamberts.

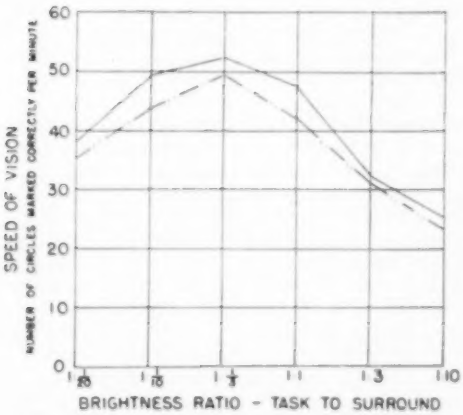


Figure 5. Average speed of vision versus brightness ratio for four-hour fatigue test, two observers. Variation in speed with change in brightness ratio is pronounced.

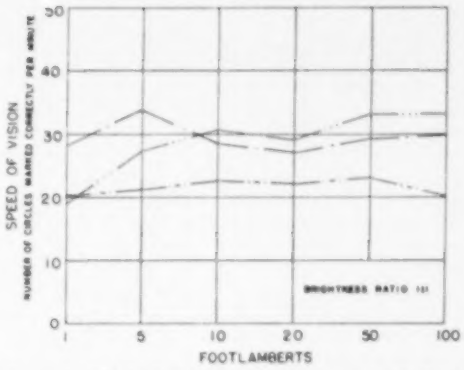


Figure 6. Speed of vision versus brightness level, three observers.

Three observers were tested; their results are given in Fig. 6.

One observer increased his performance steadily from 1 to 100 footlamberts, as expected. The second remained essentially constant throughout the range. The third, after an increase from 1 to 5 footlamberts, as expected, showed thereafter a decrease in performance from 5 to 100 footlamberts Of three observers, two do not check with the generally accepted data on light and vision.

Conclusions

The data presented here is necessarily limited to a small number of observers. As such, it cannot answer any questions. It has, however, at least in the author's mind, raised some rather fundamental questions of considerable gravity.

First, how much reliance can be placed on the accepted visual data which is based on a limited number of subjects? Second, how much reliance can be placed on the visual data which has been taken on rested eyes? Third, how much reliance can be placed on the data derived from visual tests of short duration? Fourth, is the task-to-surround brightness ratio as significant as these tests indicate? Fifth, if it is, should not the illuminating engineer be fully as concerned with this ratio as with the illumination level provided for the work?

These are questions which are fundamental to the entire structure of illuminating engineering practice. On the basis of these limited tests, it is felt that the procedures developed in this project, refined and supplemented with other indicators of fatigue, will yield significant and possibly far-reaching data.

It is therefore suggested that this pilot project be continued on a much broader basis. The information which it could be expected to produce is badly needed in lighting practice.

DISCUSSION

WILLIAM G. DARLEY*: If you give a man a hatchet and a block of wood and he works in a dark room, yet turns up with a recognizable carving, there must be a reason for it. I suspect there will be those who will get so lost in an analysis of why it can't (kaint, in Texas) be done that they will overlook the fact that Pilot Project #18 did produce data corroborating the researches of Lythgoe and others re the influence of Brightness of Surrounds on the visual function (See Biesele's Fig. 5 and Lythgoe's Fig. 9, "X. The Measurement of Visual Acuity."[1]).

For a number of years now I have been urging that the importance of Brightness Ratio be recognized; and spoke out most strongly on the subject at the Boston Conference of this Society in 1948.[2] In my opinion "the task to-surround Brightness Ratio is *at least* as important to visual performance as is the illumination level," or more important. I do not believe that the acceptance of this fact need rest on any further confirmation of the data presented in Mr. Biesele's report, which in itself merely confirms researches made and reported twenty years ago, not to mention other related work of a more recent date. I do not wish to discourage further research on the subject, neither should the impression linger that something new has been added which must await upon further confirmation before it can be accepted. I sincerely hope that Brightness Ratio *is here* and that it is here to stay, as one of the *Five* Variables of the Visual Threshold.

WILLARD ALLPHIN**: In raising two questions on Prof. Biesele's paper, I do not wish in any way to disparage what is a very valuable piece of pioneering work.

My first question is about his description of the sample task as "closely related to typical work situations." It is pretty generally conceded now that reading does not involve discrimination of fine detail, because the reader grasps words or even phrases at a time. Actually there are surprisingly few industrial tasks which require keen visual discrimination. Can Professor Biesele give two or three examples of work situations which do relate to this sample task?

My second point has to do with the 4-hour fatigue test as compared with the one-hour test. It is implied that only by extending the test to four hours was it possible to show the type of curve shown in Fig. 5, with a peak productivity at a brightness ratio of 1:⅓.

However, if we take the data from the first hour of each curve in Fig. 4 and plot it against brightness ratios, we obtain a curve almost identical with that of Fig. 5. Therefore, if only these two subjects had been considered throughout, there would seem to have been no essential difference between the 1-hour and 4-hour tests.

SYLVESTER K. GUTH*: It is always a pleasure to welcome another investigator into the relatively small group which is trying to unravel the complexities of light, vision and seeing.

As Professor Biesele has emphasized, his paper is only a report on a pilot project. Therefore, his results should be considered as exploratory rather than final for appraising comfortable seeing conditions. Some of the results are what should have been expected, and others appear to be rather inconsistent among themselves. Thus, the investigation illustrates that considerable care must be exercised in devising an experiment which involves human behavior and response.

It is not surprising that he found relatively small change in visual performance with the various brightness ratios. That there was no significant deterioration in performance during an hour of working obviously does not indicate that no fatigue was induced in the subjects. In investigations of this type, the question always arises, "Are the subjects working at their maximum rate at all times?" That such a question almost invariably is answered in the negative is evidenced by the maintenance of performance under conditions that obviously are visually severe. In the performance of most tasks, workers usually develop a rhythmic pattern. When external factors which tend to disrupt this pattern are introduced, it appears that the workers usually call upon some internal reserve resources — mental or physical — in order to maintain this rhythmic pattern. An important factor which determines the rate of working is motivation. Motivation can be largely influenced by such factors as interest or boredom, which have positive and negative effects, respectively. Furthermore, the manual and mental dexterity of a worker usually plays an important part in such investigations. For example, an individual may be performing a task as rapidly as his inherent manual dexterity will permit. An improvement in seeing conditions, such as increasing brightness levels, cannot possibly result in any greater output. Therefore, the increased ease of seeing cannot be revealed by the experimental criterion.

When comparing the results of the four-hour test with the one-hour test, it is noticed that the data do not correspond in one respect. Both tests indicate a very small and apparently not significant change in the performance between the beginning and end of the work period. However, the initial 30-minute period of the four-hour test indicated an immediate effect of the brightness ratio; that is, Fig. 5 also approximates the rate of marking of the first 30-minute period. However, the one-hour fatigue test indicates results that are almost the opposite. In fact, the one-to-one brightness ratio of the one-hour test appears to have the lowest average rate of marking. Thus it would appear that some uncontrolled factors must have been introduced which resulted in these discrepancies.

---

*Darley and Moses, Consulting Engineers, Austin, Texas.

1. Privy Council, Medical Research Council, Special Reports Series, No. 173. Published by His Majesty's Stationery Office, 1932. Also see "The Relation of the Critical Frequency of Flicker to the Adaptation of the Eye." *Proceedings* of the Royal Society (England, 105b, 1929, p. 60).

2. "Applied Brightness Engineering from the Consulting Engineer's Viewpoint," ILLUMINATING ENGINEERING, Vol. XLIII, p. 1159 (December 1948).

**Sylvania Electric Products Inc., Ipswich, Mass.

*Lamp Department, General Electric Company, Nela Park, Cleveland.

Regarding Professor Biesele's visual task, it is noted that the test pattern was approximately 1.6 inches square located in the center of an 8.5-inch square paper. This provided a relatively wide border around the details of the task. Thus the border more or less "protected" the eyes of the subjects from the surround brightness and would be expected to minimize its effect upon performance.

The five questions which Professor Biesele raises are important and I offer the following answers:

1. Only a limited amount of reliance can be placed on visual data which are based upon observations by a limited number of subjects. Such data may indicate trends and are useful for determining the relative effects of various seeing conditions. However, it must be remembered that people vary widely in their responses and reactions to environmental conditions. Therefore, it is necessary either to use a large number of subjects or, by means of suitable procedures, insure that the smaller group of subjects is representative of a larger group.

2. Experiments on rested eyes provide us with information that is useful and can be applied to lighting practice. However, in applying such data it must be remembered that seeing is a *dynamic* activity of human beings and that static tests can only serve as guides until suitable dynamic tests have been devised.

3. Most tests that involve limited duration of work period show very little effect of the experimental conditions upon performance or fatigue. In most cases this is contrary to experience, especially when prolonged work periods are involved.

4. The task-to-surround brightness ratio is significant with respect to visual comfort as has been demonstrated by many investigators. Very few have found much, if any, significance when performance has been used as the criterion. If the surround encroaches upon the details of the task, by reason of their proximity to each other, obviously the importance of task to surround brightness ratio will be greater than when the task has an extensive background.

5. Professor Biesele should be aware that the illuminating engineer is fully as concerned with brightness ratios as he is with the illumination level provided for the work. Illuminating engineering literature contains many papers emphasizing the importance of brightness relationships.

In the event that these investigations are continued, I hope that Professor Biesele will utilize all his ingenuity to so modify his experimental procedures and techniques to insure that uncontrollable factors are minimized and that such items as motivation, the limitations of manual and mental dexterity, etc. are maintained as constant as possible. Unless this is accomplished, the effects of the brightness ratios and the brightness levels are too likely to be masked by other factors.

M. E. Bitterman*: I find Mr. Biesele's results extremely interesting. As he himself notes, we cannot place much confidence in results based on such a small number of subjects, but his findings suggest that further exploration of the sensitivity and limitations of the Weston technique is essential. For example, although Weston's data on the relation between performance and illumination level have been taken very seriously, as evidenced by the British standards and the most recent report of our own SQQ Committee, two of the three subjects tested by Mr. Biesele gave deviant results.

I am especially interested in the fact that the Weston method seems sensitive to differences in brightness ratio even though it does not pick up fatigue changes consequent to four hours of work under most conditions. If we plot on Mr. Biesele's Fig. 5 a series of points representing the average performance of the two subjects at time zero (the first test in each series) we get a function which does not deviate appreciably, either in shape or in level, from the curves based on four-hour averages. This fact suggests that the use of a four-hour work period contributes nothing to the sensitivity of the index beyond what might be obtained by the use of shorter periods.

Mr. Biesele's brief presentation does not make possible a thorough evaluation of his experimental design, but there is one point that might be made. It seems likely that after the subject has rested with eyes closed for five minutes, a period of one minute is not sufficient to permit adequate adaptation to the experimental conditions of illumination. It is difficult to say what effect this procedure may have had. In general, however, it should be noted that investigations of this kind present extremely complex problems of experimental design which should be studied carefully before large-scale studies are undertaken.

Gertrude Rand Ferree†: White area surrounding test objects is too large. The ordinary reading material has type comparatively near the edge of the paper. The test page subtends 30 degrees and thus the effect of the surround could not be expected to be of too much influence on actual performance.

The visual angle should possibly have been less to have shown the greater relative effect of surround. Speed-of-reading tests with 8-point type (of comparative visual angle to test objects) show little effect of illumination above a few footcandles.

The method of scoring obscured the effects desired. The difficulty of gross performance scores is that action time has not been eliminated and it is relatively large in comparison with the net visual time. Also, there should have been an accuracy multiplier in order to obtain net correct cancellations with penalty for omissions. Possibly the results could be rescored and presented in a revised form.

Figure 6 is not surprising in view of the large detail and high contrast of the test object, the small number of observers, the inclusion of action time and the omission of an accuracy factor in the performance score. Average performance score for the three observers, even as rated, shows increase from 1 to 5 footcandles and little if any to 100. This is quite similar to Weston's results (average of 18) for the same size and contrast, except that he found a *slight* increase from 4 to 100 footcandles. Few lighting men realize how the intensity curves change with size of detail and degree of contrast.

*University of Texas.

†Sylvania Electric Corp., Alexandria, Va.

It is well to stress once more the factor of time of light adaptation. One minute is not enough. This is shown in Ferree and Rand's reply to Luckiesh's paper on the "li" test used as a measure of fatigue (*I.E.S. Transactions*, 1927). For example, a rough average of performance score at the end of one hour for the different brightnesses of surrounds, at which time light adaptation would be complete (Fig. 4, a-f, Biesele's paper) shows these averages:

1:1/20	37
1:1/10	46
1:1/3	56
1:1	46
1:3	34
1:10	27

They are of the general order of the scores for the total four-hour periods (Fig. 5). It is possible that with the observer at the limit of practice, a full four-hour period is not necessary. This is not brought out clearly in the Test Procedure #2, but probably learning was still present in those results. It is assumed that the two observers used in the four-hour test had also been used in Test Procedures #1 and #2.

R. L. Biesele, Jr.*: The comments of the various discussors are both pertinent and appreciated. They cover points which should be considered and, in many cases, incorporated into further research in this field. Lest there be any misunderstandings, no criticism of previous research by others was intended by the inclusion of the questions at the end of the paper. They were placed there to emphasize the complexity of the entire field of visual research.

There are possible answers to the various questions which have been posed by the discussors, but such answers would at this stage rest almost entirely on conjecture. Possibly the most serious question posed is the discrepancy between the performance rate for four hours as compared with the performance rate for one hour. Since one of the observers took both the one-hour and the four-hour test, and his scores exhibit the same discrepancy, he was questioned with regard to the discrepancy. His suggestion is perhaps pertinent. He knew the four-hour test would be difficult, and consequently had a tendency to pace himself somewhat slower for the more difficult four-hour task. Here, then, is a good example of the effect of motivation on this type of test. However, it might seem logical to expect the same sort of attitude to enter into a normal work situation where the work was to be continued throughout the day.

What is perhaps needed the most is some way of measuring not only the actual performance in a test of this type, but also the actual expenditure of energy which is involved in such performance. It seems desirable therefore that we include some such indicator as muscle tension or muscle action potential into the test procedure on a further extension of this test program. In any event, I believe that an extension of visual testing to cover longer periods of time may produce data which are significantly different from data we now have which have been taken predominantly over short test periods with the eyes rested. I also feel that additional study of the effect of brightness ratios on visual performance is essential to future illuminating engineering practice.

*Author.

Fluorescent Lighting for a City Street

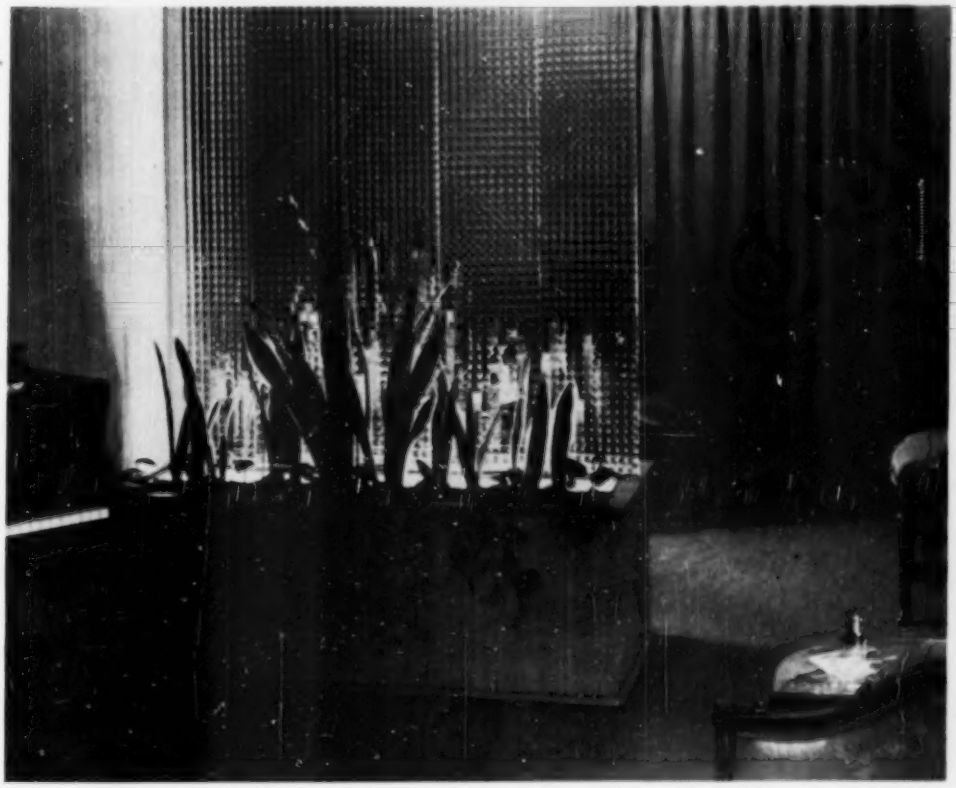
One of the first major fluorescent street-lighting systems was placed in operation recently by the Detroit Public Lighting Commission. Illuminating a half-mile stretch of one of Detroit's main traffic arteries, the new "white way" system uses eight-foot-long tubular units. Twenty-four luminaires are mounted 25 feet above the pavement on wooden poles, spaced 140 feet apart between intersections and 100 feet apart at intersections. The average calculated illumination level along the half-mile stretch is 1.0 footcandle.

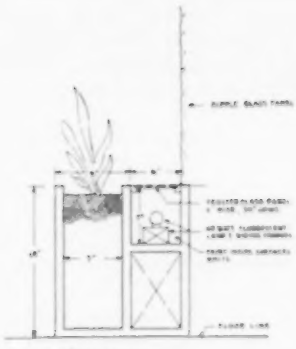
The luminaires are composed of two separate aluminum reflector units, joined at a lateral angle of 30 degrees. Each reflector contains two fluorescent lamps and has clear plastic windows. The four lamps in each unit produce 19,000 lumens of light. (Photo: courtesy of General Electric Co., Schenectady, N. Y.)

Decorative Lighting Effects

Installation "A," Lighting a Flower Box

LIGHTING OBJECTIVE: To provide decorative lighting fora flower box against a background of glass between living and dining room.





Cross Section

Installation at Cincinnati, Ohio; built by J. Lehman.

General Information: The flower box is 55" x 9" x 18". It is constructed of grey Weldtex (U. S. Plywood Corp.) and backed with ripple glass panels (Libbey Owens Ford Glass Co.).

Installation: One 40-watt T12 fluorescent lamp and channel strip is recessed in the back of the box 7" below the top. The 6" wide opening is covered with a 50" x 5" sandblasted glass panel.

Lighting data submitted by Stella M. Fetzer, Cincinnati Gas and Electric Company.

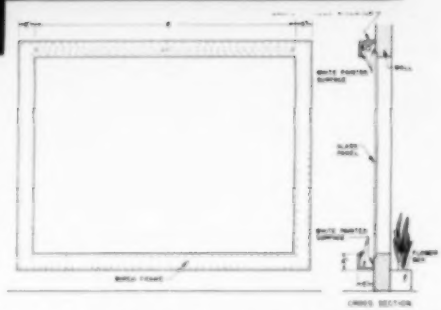
(over)

A.I.A. File No. 31/12

Installation "B," Lighting an Interior Picture Window

LIGHTING OBJECTIVE: To give emphasis to an interior picture window at night.

Installation at Detroit, Michigan; architect: Louis G. Redstone.



General Information: The living room is 16′ x 29′ with an 8′9″ ceiling. A 6′ x 8′ glass panel on one wall of the living room furnishes an extended view into the adjoining sunroom. To give the feeling of an outdoor scene, a window box of foliage has been placed on the floor in the sunroom beside the glass panel.

Installation: Six-inch boards finished to match the sunroom panelling have been applied to the living room side of the wall partition to frame the 6′ x 8′ glass window. The frame extends 6½″ out from the wall thus forming a pocket around the window. All inside pocket surfaces are painted a matte white and two 4-watt fluorescent lamps (on Wiremold channel #3000) are installed end to end behind the upper frame. These concealed lamps give a downward spread of light to emphasize the large picture window, and at the same time they transmit a subtle accent of light through the glass window, over the long box of foliage into the sunroom.

Footcandle readings taken along the top of the plants showed a lighting level of 8 to 15 footcandles.

Lighting data submitted by Mary Tarpke, The Detroit Edison Co., and Anthony Fodell, Madison Electric Co., Detroit, Michigan, as one solution of a home lighting problem and to aid in the design of similar installations.

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Fluorescent Lighting in the Home — Part I

By E. W. COMMERY
KAYE A. LEIGHTON

THE INTRODUCTION of the fluorescent lamp in 1939 presented new possibilities for lighting design in the home. Experimentation over a period of ten years is crystalizing these potentials into definite patterns, creating an expression of beauty, functional service and livability, which the home has never before enjoyed. The advent of the fluorescent lamp greatly minimized many of the installation problems that have been inherent with incandescent lamps. Ease of construction, installation and maintenance, has already brought about marked evidence of public desire for, and expressed satisfaction with, these new patterns for lighting. The scope of application and acceptance has increased accordingly.

The authors believe that we are also at the beginning of a new era — the acceptance of "whiter" light sources within the home. Incandescent lamps, when appraised by accepted standards of evaluation prove to be reasonably saturated yellow-red light sources. The "warm white" fluorescent lamps currently available simulate the light from filament sources. This development is a desirable transition step paralleling the earlier transition when the flame-tint electric lamp was introduced to simulate flame sources which have been used for centuries.

The move toward white light sources began with the invention of the carbon lamp. Each increase in lamp efficiency has slowly but steadily marked progress in this direction. It is not difficult to recall that some people, in fact many residential designers, questioned the "whiteness" of, for example, the 1-2-300-watt three-light incandescent lamp when it was first produced and used in reflector floor lamps in 1933. Today a complaint that the light from this lamp is "too white" would be most unusual.

The present significant step forward toward a whiter light acceptance is the "cool white" fluorescent lamp. It may out-mode the warmer light sources, for it is bringing forth a new freshness of atmosphere and clarity of color rendition, that is in keeping with the interior design trends of the times. The movement is away from the imported traditional, to a truly American expression of surroundings for living — comfortable, colorful, and beautifully efficient. This "whiter" light becomes a natural coordinator of the modern artisans' craftsmanship. Thus we see that it is only by recalling past evolutionary transitions that we are able to gauge the future with a degree of accuracy and assurance.

While this movement toward whiter light sources is already established, the warmer sources will continue to be used. In fact the lighting specialist and interior designer will learn the color rendition characteristics of both warm and cool illuminants used alone and in combinations with each other. As more observational and technical data in this field are acquired, the great and complex uncharted area of illuminants and colored materials, as used in interiors, will be clarified and *then* we can choose colors and illuminants with certainty and intent.

Today we have at least six illuminants to consider, namely natural daylight, incandescent filament lamps and four fluorescent lamps. Each of these may change the color appearance of almost every surface in varying amounts and in varying ways. The rather startling apparent color changes associated with various illuminants, when brought beside each other, have long left public audiences gaping. The serious designer has been confused by them. This confusion abounds at every level from the ultimate user through the merchandiser and interior designer, to the color printer and paint and dye mixers.

One of the major endeavors of this present work is that of attempting to develop both procedures for observation, and statements of the observable effects of these modern illuminants when used to illuminate a range of surface colors. From these procedures we may record both computed data and the observed changes that take place. We may ultimately learn how to predict and design with adequate assurance in terms that are understandable to the artist and acceptable to those with scientific interest.

It is recognized that in great numbers of interiors color effects and color rendition are not of paramount importance. In these, a reasonable color rendition will suffice, especially when the less favor-

Part I of a paper presented at the National Technical Conference of the Illuminating Engineering Society held August 21-24, 1950, Pasadena, California. Part II—Fluorescent Lighting Design, will appear in the January 1951 issue. The authors are Head of Residential Lighting and Residential Lighting Specialist, Engineering Division, Lamp Department, General Electric Company, Cleveland, Ohio, respectively.

able color rendition illuminants provide substantially higher amounts of light for the same energy consumption. Consult the fluorescent lamp manufacturers light output data on "standard" and "deluxe" white fluorescent lamps. If the most efficient illuminants have certain peculiarities in rendering certain colors, a knowledge of these peculiarities will provide the knowledge for avoiding unhappy combinations of the illuminant and these colors.

The growing interest in the use of color in the home both at high and low values as well as higher purities, is reflected from the furnishings and wall treatments found in even the modest income home. There is also a real awakening to color for its environmental potentialities.

Color Rendition Studies

In the study of the surface colors reported here a selected artificial daylight is used as a standard

TABLE I.—Appearance of the Selected Samples of Surface Colors When Viewed Under the Two Reference Illuminants.†
(Table V forms the basis for the descriptive naming of the colors.)
House and Garden Color Samples for 1949-50.

NO.	COLOR NAME	"DAYLIGHT" ILLUMINANT "Bu" 4370° K*	MUNSELL DESIGNATION	INCANDESCENT FILAMENT ILLUMINANT "A" 2848° K**	MUNSELL DESIGNATION
3	Carnation	PINK, cool	5YR8/7	PINK, cool	5YR8.2/12.5
19	Ruby	RED, cold (toward blue)	7R4/13	RED, orange vivid	8.4R4.5/16.5
15	Flame	RED, cool	7.5R6/14	RED orange strong	9R6.3/18
2	Sweet Pink	PINK, slightly bluish	4.5YR8.3/7	Yellow PINK, warm	3.5YR8.5/13
1	Citron yellow	YELLOW-slight green cast	3.5Y8.8/8.5	YELLOW, warm, pale	8.5YR9/14
6	Mustard	YELLOW-slight orange cast	2Y7/10	ORANGE yellow—no green	7.5YR7.3/14
16	Avocado	GREEN yellow	1.5GY5.3/5.8	GREEN, brownish cast	2.5Y5.2/8
4	Sprout	GREEN yellow	1GY8/8	YELLOW GREEN, dull	2.5Y8/11
18	Leaf	GREEN	10GY4/5.2	Medium GREEN, yellow cast	3.5GY3.9/5.5
12	Kingfisher	BLUE GREEN	10GY6.3/3.7	Yellow-GREEN, grayed	7.5Y6.1/5
22	Forrest	BLUE GREEN, deep	9.5GY3/2.5	Yellow-GREEN, deep	1.5GY3/3.6
10	Willow	Blue GREEN, grayed	7Y6.7/4.5	Grayed GREEN, yellow-red cast	10YR6.7/9
9	French Blue	BLUE—no cast	4GY7/1.5	BLUE, warm no red	8.5YR6.8/6
7	Heather	Red PURPLE	10R7/4.5	Orange PINK, slightly dull	3YR7/9.5
11	Hyacinth	BLUE purple	5YR6/1.25	GRAY, warm yellow cast	7.5YR6/5.8
21	Bright Navy	BLUE purple cast	2.5PB3.3/9	BLUE-gray, low in color	1.5Y2.8/2.2
17	Copper	BROWN-orange	3.5YR5/9	ORANGE RED	2.2YR5.2/13.5
13	Sandalwood	BROWN—tinged red	7.5YR6.2/6	YELLOW, red brown	5.5YR6.3/10
20	Chocolate	Red BROWN—purple tinged	5YR3.7/4.2	Yellow RED BROWN, warm	5YR3.8/7.8
5	Parchment	GRAY—yellow	2.5Y7.4/5.5	Yellowish GRAY	8.5YR7.6/10.5
8	Stone	GRAY, warm	10YR7/4	Reddish GRAY, warm	7.5YR7/9
14	Pewter	GRAY, blue cast, cool	2.5Y6/3.5	Warm GRAY	9YR6/8
		WINSOR AND NEWTON LTD. ARTIST COLORS			
Cadmium Yellow		YELLOW, cool	7.5YR8/15.5	Orange YELLOW	4.5YR7/17
Chrome Orange		ORANGE	1.7YR5.5/14.5	ORANGE RED	1.9YR5.8/16.5
Vermilion		RED orange, slight cold cast	9.2R5.6/13.5	RED orange	8.5R5/18
Green		GREEN	9GY4.4/6.5	YELLOW GREEN	4GY4.2/6.3
Green		GREEN, deep, slightly bluish	9GY3.4/3.75	GREEN, deep, warm	10Y3.2/4
Alizarin Crimson		Blue RED, deep	7.5R3/9	Brown, RED, deep	9.5R3.1/11.5
Cobalt Blue		BLUE, clear	7.5PB3.1/10	BLUE, deep	7.5PB2.8/5
Ultramarine Blue		BLUE, purple, deep	9PB2.2/12	BLUE purple	8Y2.2/3.5

†Verbatim repeat of word description for a given sample color means that they are essentially identical in appearance.

*"DAYLIGHT" ILLUMINANT Bu—4370° K
Incandescent filament lamps with color correction filters were used to obtain an approximation of daylight at this specified color temperature. The color temperatures of "Standard and Deluxe" Cool White fluorescent lamps are also approximately matched by this source.

**INCANDESCENT—FILAMENT, ILLUMINANT A—2848° K
The color temperature (°K) of this light source "Illuminant A" is close to that obtainable with 75- and 100-watt Inside Frosted lamp bulbs.

of comparison for appraising the color rendition qualities of the two *cool* white fluorescent lamps, the "standard" and "deluxe."

The light from incandescent filament lamps is also used; it is the standard of comparison for appraising the color rendition qualities of the two *warm* white fluorescent lamps, the "standard" and "deluxe." The three cool illuminants are appraised separately from the three warm illuminants. These two sets of appraisals are made at different times.

These two comparison light-sources were chosen since each is closely related in coolness and warmness respectively to the "standard" and "deluxe" *cool* and the "standard" and "deluxe" *warm* fluorescent lamps. The selected cool comparison source termed "Bn" provides color rendition, which follows natural daylight. It is not as cool as the I.C.I. illuminant "C," or other daylight color matching units at or near 6500° K. The other comparison source, the incandescent filament lamp, I.C.I. illuminant "A," holds an established place in our experiences. Its choice is obviously a natural one, and for practical purposes it can be reproduced with 75- to 100-watt inside frosted lamps. The much cooler daylight fluorescent is not included since experience at this time indicates very little acceptance of it in residential interiors.

The surface colors used for analysis were obtained from the magazine *House and Garden*. This group of 22 colors is composed of two sets. Twelve are termed Current Colors. These are based on the Rahr Color Count, a nation wide survey of over 400,000 votes polled in leading stores to determine colors that people want most to buy. The remainder are called Decorator Colors. They come from the palette of outstanding decorators, and it is believed that they are the trend setting colors in the home furnishings field. The entire set is the 1949-50 group. Tables I to IV present the various aspects of this color rendition analysis.

The Current Colors are named Citron Yellow, Sweet Pink, Sprout, Heather, Stone, French Blue, Kingfisher, Flame, Avocado, Leaf, Bright Navy and Forest. The Decorator Colors are named Carnation, Parchment, Mustard, Willow, Hyacinth, Sandalwood, Pewter, Copper, Ruby and Chocolate.

In addition a selected group of Winsor and Newton artists water colors were studied. These stable, high purity colors were applied with an air brush until the fully saturated color was obtained.

The appearance of colored surfaces is dependent upon many factors, some of which may be beyond the control of the experimenter. In this analysis every effort was made to minimize undesirable and extraneous influences. At the same time conditions were developed to provide great ease for making the comparisons of color rendition. The ease with which both skilled and unskilled observers reported their observations was assuring. Groups of observers also reported the same color appearances as did individuals on different days. The usual difficulties of color naming is, of course, not eliminated by the visual procedure employed. Table V forms the basis for the descriptive naming of colors, since some system of names and qualifiers is needed that will serve the lighting practitioner, interior designer and the layman for use in the residential field.

Some of the conditions under which these observations were made are set forth so that the specific appraisal of the value of these observations can be related to the problems of interior design. A new color rendition comparator was developed for these studies. This device provides the equivalent of adjacent photometric fields with color samples 3 inches by 6 inches split in half by thin metal partitions. These partitions enclose spaces for each illuminant and they prevent mixtures of the illuminants. Actually five illuminants can be compared with each other at one time. Here we are only reporting three, two when compared with the reference standard for (a) cool white and (b) warm white.

Visual adaptation to the illuminants was minimized by surrounding the color samples with black surfaces, and by enclosing and shielding the lamps from view. This also reduced scattered light out to the room in which the observer was placed. Several viewing distances were used ranging from two to eight feet. Several low values of room illumination were tried. At these levels the surrounding illumination did not alter the appearance of the viewed color samples. At all times the incident illumination from each illuminant was held close to 35 footcandles. Moderate variations of the intensity of incident light will alter the apparent color of a surface. The color samples were never presented to the observers outside the color rendition comparator, and they were always concealed from the observers when being changed in this device. Only specimens of one color were viewed at one time. Everything was done to provide conditions for viewing each color objectively. Even the effect of strengthening or weakening a color by contrasting it with some other color, was held to a minimum. This factor is introduced when the three illuminants produce significant color changes in a given color. It is never very great. Under these conditions most of the observations are made with ease and certainty.

TABLE II-A.—Appearance Changes of Surface Colors WhenViewed Simultaneously Under Three Different Illuminants.†

(Table V forms the basis for the descriptive naming of the colors.)

"Daylight" (Incandescent-Filament with Filter) Basis for Comparison.‡

NO.	SAMPLE COLOR — House & Garden For 1949 & 50	Reflectance %	"DAYLIGHT" ILLUMINANT Bn—4370° K	FLUORESCENT DELUXE COOL WHITE	FLUORESCENT STANDARD COOL WHITE
			REFLECTANCE UNDER ILLUMINANT Bn—74 PERCENT		
1	Citron yellow	74.3	YELLOW—slight green cast	YELLOW-Green cast	YELLOW—tinged with green, grayed
			REFLECTANCE UNDER ILLUMINANT Bn—66 to 60 PERCENT		
2	Sweet Pink	66.2	PINK, slightly bluish	PINK, more colorful—increase in red	PINK, less colorful—decrease in red
3	Carnation	59.8	PINK, cool	PINK, more colorful—purplish	PINK, cool—weak in color
4	Sprout	59.8	GREEN-yellow	GREEN-yellow, increase in yellow	GREEN-yellow, faded
			REFLECTANCE UNDER ILLUMINANT Bn—50 to 40 PERCENT		
5	Parchment	49.7	GRAY-yellow, cool	GRAY-yellow, red cast	GRAY-yellow, cool
6	Mustard	44.1	YELLOW, pale—slight orange cast	YELLOW, tinged with green—pale	YELLOW-green
7	Heather	43.7	Red PURPLE	Red-PURPLE—red increase	Red PURPLE, weaker
			REFLECTANCE UNDER ILLUMINANT Bn—42 to 38 PERCENT		
8	Stone	42.2	GRAY, warm—pinkish	GRAY, warm—more pinkish	GRAY, warm—slight yellow cast
9	French Blue	42.4	BLUE, no trace of cast	BLUE, slight red cast	BLUE, increase in red
10	Willow	39.	Blue GREEN, grayed	Blue GREEN, grayed	Blue GREEN, more grayed—pinkish cast
11	Hyacinth	37.5	BLUE-purple	BLUE-purple, deeper	BLUE-purple, deepest
			REFLECTANCE UNDER ILLUMINANT Bn—34 to 30 PERCENT		
12	Kingfisher	33.8	BLUE-GREEN, clear—vivid	BLUE-GREEN, slight green increase	BLUE-GREEN, grayed
13	Sandalwood	32.0	BROWN, tinged with red	BROWN, increase in red	Yellow BROWN
14	Pewter	31.0	GRAY, blue cast—cool	GRAY, pinkish cast—warm	GRAY, warm
15	Flame	30.2	RED, cool	RED, cool	RED, cool—weak and faded
			REFLECTANCE UNDER ILLUMINANT Bn—22 to 20 PERCENT		
16	Avocado	22.4	GREEN-yellow	GREEN-yellow, warmer	GREEN-yellow, slightly brownish
17	Copper	20.4	BROWN-orange	BROWN-orange, slightly redder	BROWN-orange, yellowish—weak
			REFLECTANCE UNDER ILLUMINANT Bn—13 to 11 PERCENT		
18	Leaf	12.5	GREEN	GREEN	GREEN, dulled
19	Ruby	12.4	RED, cold (toward Blue)	RED, slightly warmer (less blue)	Red BROWN, grayed—faded
20	Chocolate	10.6	Red BROWN—tinged with purple	Red BROWN, increase in red purple	Red BROWN, grayed
			REFLECTANCE UNDER ILLUMINANT Bn—8 to 6 PERCENT		
21	Bright Navy	8.3	BLUE—purple cast	BLUE-purple	BLUE-purple, deeper
22	Forrest	6.4	BLUE GREEN, deep	BLUE GREEN, decrease in blue	Brownish GREEN, dark

TABLE II B—APPEARANCE CHANGES OF SURFACE COLORS

Winsor & Newton Water Colors				
Cadmium Yellow	50	YELLOW, cool	YELLOW, cool	Greenish YELLOW, Pale
Chrome Orange	25	ORANGE	ORANGE, slightly redder	Yellow BROWN, Pale
Vermilion	17	RED Orange, Slight cold cast	RED Orange, Slightly redder—more colorful	BROWN, light
Alizarin Crimson	7	Blue RED, Deep	Blue RED, brighter color	Purplish BROWN, deep
Green Light (Oil)	15	GREEN	GREEN, Slightly paler and yellower	GREEN, grayed
Green Dark (Oil)	9	GREEN, Deep—slightly bluish	GREEN, Deep—decrease in blue	GREEN, Dark—dull
Cobalt Blue	7	BLUE, clear	BLUE, Substantially more purple (cast)	BLUE, decrease in purplish cast
Ultramarine Blue	4	BLUE-purple—Deep	BLUE—lighter—slight amount of purple	BLUE—lighter

†Verbatim repeat of word description for a given sample color means that they are essentially identical in appearance.

‡"DAYLIGHT" ILLUMINANT Bn—4370° K

Incandescent filament lamps with color correction filters were used to obtain an approximation of daylight at this specified color temperature. The color temperatures of "Standard and Deluxe" Cool White fluorescent lamps are also approximately matched by this source.

Table I presents the appearance of each color under the two reference or comparison illuminants when they are viewed alone. The shifts toward the warm illuminant, the incandescent filament, and even marked color changes may be noted throughout.

The numbers of the samples take different positions in the different tables. This table groups the samples by their colors. Table II establishes the order based upon the order of the reflectances of the samples under the "daylight" reference source. The order changes somewhat in Table III, since the reflectances change under the warmer reference illuminant.

Both Tables I and IV contain the Munsell Designation of all color samples. These were derived from the trichromatic coefficients plotted on the appropriate Munsell Value Diagrams for illuminant "C."[1] Table IV it will be noted includes illuminant "C." A 30 selected ordinate method was used for determining the trichromatic coefficients. The I.C.I. tristimulus "Y" values are used as the reflectances of the samples under the various illuminants.[2]

A careful review of the observations contained in Tables II and III shows in what ways each of the four new fluorescent lamps render each color. One way to group these observations is to have all those of each principle color group together. Such a detailed summary follows. At all times the reflectance of the color should be borne in mind, the naming does not attempt to carry the value of the color, since the numerical reflectances may serve far better. The Munsell chroma values are extremely helpful in sensing the purity or color saturation. It should be noted that the samples include some extremely high chroma values.

Color Rendition Under "Deluxe" "Standard" Cool White Fluorescent Lamps

Reds (bluish to yellowish 3, 19 and 2) under "deluxe" show slight red increase. Sample 15, strong red at 30 per cent reflectance unchanged. Dominant color of this series unchanged. Under "standard" each sample is either weakened or faded. No. 19 becomes red brown, grayed and faded.

Yellow Greens (1, 6, 16 and 4) under "deluxe" tend to show slight greenish tinge increase, or yellow increase depending upon whether they are greenish or yellowish respectively. Dominant color of the series essentially unchanged. Under "standard" each of the green samples grays or fades moderately.

Green (18) reproduced closely under "deluxe." Under "standard" becomes dulled. .

Blue Greens (12, 22 and 10) under "deluxe" follow slightly different patterns. No. 12 increases in green, 22 decreases in blue, 10 is reproduced closely. Dominant color of series is essentially unchanged. Under "standard" 12 grays, 22 becomes brownish green, and 10 grays and also exhibits a pinkish cast.

Blue (9) under "deluxe" takes on slight red cast. Dominant color essentially unchanged. Under "standard" the red cast of the "deluxe" increases moderately.

Red and blue purples (7, 11 and 21) under "deluxe" show moderate reddish or purplish increases for the red and blue purples respectively. Dominant color essentially unchanged. Under "standard" 77 weakens; 11 and 12 deepen.

Browns (orange brown to purple brown 17, 13 and 20) under "deluxe" all show small red increase. Dominant color essentially unchanged. Under "standard" 17 yellows and weakens; 13 becomes yellow brown and 20 grays.

Grays (yellowish, pinkish, bluish 5, 8 and 14) under "deluxe" show reddish or pinkish cast. Dominant color may be altered. Under "standard" they show either slight yellowishness or loss of pinkishness.

Color Rendition Under "Deluxe" and "Standard" Warm Fluorescent White Lamps

Reds (bluish to yellowish 3, 19 and 2) are now shifted to warmer and stronger colors when viewed under the light from the incandescent lamp. Under "deluxe," 3 becomes slightly colder, 19 increases in red, 2 increases in red in comparison with their appearance under incandescent filament (Illuminant "A"). Color 15 the strong red matches incandescent filament. Under "standard" 3 is slightly colder and weaker, 19 shifts to yellow red brownlight, 15 is still red orange, though weaker, and 2 remains yellow red though weaker.

Yellow Greens (1, 6, 16 and 4) lose much of their greenishness under incandescent filament ("A"). They become yellow, orange, yellow, green brownish-cast and yellow-green dull, respectively. Under "deluxe" sample 1 takes on some greenishness, 6 shows a yellow increase, 16 the brownish cast changes to slightly yellowish tinge, and 4 remains the same in color although sharper. Under "standard" 1 is still greenish, 6 shows some yellow in-

1. Newhall, Sidney M., Nickerson, Dorothy, and Judd, Deane B.: "Spacing of the Munsell Colors." Journal of The Optical Society of America, Vol. 33, No. 7, p. 385-418 (July 1943).
2. Hardy, A. C.: "The Handbook of Colorimetry." Technology Press (1936).

TABLE III-A.—Appearance Changes of Surface Colors When Viewed Simultaneously Under Three Different Illuminants.[1]
(Table V forms the basis for the descriptive naming of the colors.)
(Incandescent-Filament Basis for Comparison).[2]

NO.	SAMPLE COLOR House & Garden Pot 1949 & 50	Reflectance %	INCANDESCENT ILLUMINANT A—2848° K[3]	FLUORESCENT DELUXE WARM WHITE	FLUORESCENT STANDARD WARM WHITE
			REFLECTANCE UNDER ILLUMINANT A—78 PERCENT		
1	Citron yellow	78.1	YELLOW, warm, pale	Green YELLOW, pale	Greenish YELLOW, pale
			REFLECTANCE UNDER ILLUMINANT A—69 to 60 PERCENT		
2	Sweet Pink	69.5	Yellow PINK, warm	Yellow PINK, slight red increase	Yellow PINK, weaker
3	Carnation	63.1	PINK, cool	PINK, colder—more blue	PINK, colder—weaker color
4	Sprout	60.0	YELLOW GREEN, dull	YELLOW GREEN, sharper color	YELLOW GREEN, dull
			REFLECTANCE UNDER ILLUMINANT A—52 to 43 PERCENT		
5	Parchment	52.3	Yellowish GRAY	Yellowish GRAY, greenish cast	Yellowish GRAY, slight greenish cast
6	Mustard	47.1	ORANGE yellow, no greenishness	ORANGE yellow, increase in yellow	ORANGE yellow, increase in yellow
7	Heather	44.8	Orange PINK, slightly dull	Orange PINK, slightly dull	Orange PINK, slightly dull
8	Stone	43.2	Reddish GRAY, warm	Warm GRAY, neither red or blue cast	Warm GRAY, slightly pinkish-weaker
			REFLECTANCE UNDER ILLUMINANT A—40 to 30 PERCENT		
9	French Blue	40.5	BLUE, warm—no red	BLUE, warm—no red	BLUE, purplish cast—faded
10	Willow	39.2	Grayed GREEN, yellowish red cast	Yellow-GREEN	Grayed GREEN, yellowish cast—faded
11	Hyacinth	37.5	GRAY, warm—yellowish cast	GRAY, warm—purplish	BLUE-pink, pale
15	Flame	33.5	RED orange, strong	RED orange, strong	RED yellow, weaker
13	Sandalwood	33.2	YELLOW red brown	YELLOW red brown, grayed	YELLOW red brown, grayed
12	Kingfisher	31.7	Yellow-GREEN, grayed	Yellow-GREEN, clear	BLUE grayed, very faded
14	Pewter	30.6	Warm GRAY	Greenish GRAY, deep	Pinkish GRAY
			REFLECTANCE UNDER ILLUMINANT A—22 PERCENT		
17	Copper	22.2	ORANGE RED, medium	ORANGE RED, slightly less red	Dull ORANGE YELLOW
16	Avocado	21.9	GREEN, brownish cast	GREEN, slightly yellowish—clearer	GREEN, brown cast—slightly lighter
			REFLECTANCE UNDER ILLUMINANT A—15 to 11 PERCENT		
19	Ruby	15.2	RED orange, vivid	RED orange, increase in red	Yellow RED BROWN, light
18	Leaf	11.7	Medium GREEN, yellow cast	Medium GREEN, slightly brighter	Medium GREEN, dull and weak
20	Chocolate	11.2	Yellow RED BROWN, warm	Yellow RED BROWN, less warmth	Yellow RED BROWN, less warmth
			REFLECTANCE UNDER ILLUMINANT A—7 to 6 PERCENT		
22	Forrest	7.3	Yellow GREEN, deep	Yellow GREEN, deep	Brownish GREEN, dark
21	Bright Navy	5.8	BLUE-gray, low in colorfulness	BLUE-gray, slight increase in red	Red PURPLE
Winsor & Newton Water Colors			**TABLE III B—APPEARANCE CHANGES OF SURFACE COLORS**		
Cadmium Yellow		56	Orange YELLOW	Orange YELLOW, slightly pink	Green YELLOW, Medium
Chrome Orange		28	ORANGE RED	ORANGE RED, slightly clearer	YELLOW Brown, Medium
Vermilion		20	RED, orange	RED, orange, slightly yellower	Yellow BROWN
Alizarin Crimson		7	Brown RED, deep	Brown RED, moderate increase in red	BROWN
Green (Light) Oil		14	YELLOW GREEN	YELLOW GREEN (medium) slightly more colorful	Grayed GREEN, Dull—indefinite
Green (Dark) Oil		8	GREEN, Deep-warm	GREEN, slightly yellower	GREEN, grayed—dull—warm
Cobalt Blue		6	BLUE, Deep	Red PURPLE, brighter more colorful	Red PURPLE, brighter more colorful
Ultramarine Blue		4	BLUE Purple	BLUE Purple, deep	BLUE Purple, deep

[1]Verbatim repeat of word description for a given sample color means that they are essentially identical in appearance.
[2]INCANDESCENT—FILAMENT, ILLUMINANT A—2848° K
[3]The color temperature (°K) of this light source "Illuminant A" is close to that obtainable with 75- and 100-watt Inside Frosted lamp bulbs.

crease and 16 goes back to green brown-cast slightly lighter, and 4 goes back to yellow green-dull.

Greens (18) under incandescent becomes a medium green with a yellow cast. The "deluxe" matches the incandescent although the color is slightly brighter. Under "standard" the color is also medium green though dull and weak.

Blue Greens (12, 22 and 10) under incandescent become yellowed and grayed, and in the case of 10 it also takes on a yellowish red cast. Under "deluxe" warm fluorescent the yellowed green character is maintained with some increase in clearness with 12, and the red cast mentioned for 10 drops out. Under "standard" warm fluorescent 12 becomes a grayed blue—faded, 22 shifts to a brownish green, and 10 is like the incandescent a grayed green with a yellowish cast, although somewhat faded.

Blue (9) becomes warm under incandescent with no trace of pinkishness or red. This is closely

TABLE IV.—Specification Changes of Surface Colors Under Three Illuminants.

NO.	COLOR SAMPLE	ILLUMINANT A—2848° K*				ILLUMINANT Bs—4370° K**				ILLUMINANT C—6500° K			
		Reflectance %	MUNSELL DESIGNATION	TRICHROMATIC COEFFICIENTS		Reflectance %	MUNSELL DESIGNATION	TRICHROMATIC COEFFICIENTS		Reflectance %	MUNSELL DESIGNATION	TRICHROMATIC COEFFICIENTS	
	Home & Garden For 1949 & 50	%	"A"	x	y	%	"Bs"	x	y	%	"C"	x	y
1	Citron	78.0	8.5YR9/14	.485	.437	74.0	3.5YR8.8/8.5	.415	.428	76.0	10YR8.8/5	.367	.403
2	Sweet Pink	70.0	3.5YR8.5/13	.496	.397	66.0	4.5YR8.3/7	.417	.372	66.0	7.4R8.3/4.25	.359	.328
3	Carnation	63.0	5YR8.2/12.5	.490	.393	60.0	5YR8/7	.420	.376	58.0	2.5R8/4.4	.350	.318
4	Sprout	60.0	2.5Y8/11	.460	.457	60.0	1GY8/8	.394	.452	60.0	7GY8/6	.350	.424
5	Parchment	52.0	8.5YR7.6/10.5	.471	.422	50.0	2.5Y7.4/5.5	.397	.399	51.0	3Y7.5/2.5	.345	.355
6	Mustard	47.0	7.5YR7.3/14	.516	.436	44.0	2Y7/10	.462	.446	43.0	4Y7/7	.420	.430
7	Heather	45.0	3YR7/9.5	.464	.382	44.0	10R7/4.5	.376	.338	43.0	7.5P7/4.5	.313	.285
8	Stone	43.0	7.5YR7/9	.459	.411	42.0	10YR7/4	.381	.376	42.0	10YR7/8	.325	.329
9	French Blue	41.0	8.5YR6.8/6	.413	.392	42.0	4GY7/1.5	.324	.344	43.0	2PB7/4	.271	.285
10	Willow	39.0	10YR6.7/9	.455	.424	39.0	7Y6.7/4.5	.372	.404	39.0	8GY6.7/2.6	.320	.361
11	Hyacinth	38.0	7.5YR6/5.8	.421	.387	38.0	5YR6/1.25	.334	.330	38.0	7.5PB6.6/4.0	.278	.273
15	Flame	34.0	9R6.3/18	.591	.353	30.0	7.5R6/14	.528	.349	27.0	5R5.7/10	.474	.326
13	Sandalwood	33.0	5.5YR6.3/10	.494	.406	32.0	7.5YR6.2/6	.418	.385	31.0	5YR6.1/2.5	.362	.344
12	Kingfisher	32.0	7.5Y6.1/5	.391	.421	34.0	10GY6.3/3.7	.310	.377	35.0	5BG6.4/4.5	.259	.327
14	Pewter	31.0	9YR6/8	.455	.415	31.0	2.5Y6/5.5	.375	.380	32.0	10Y6.1/7.5	.320	.331
17	Copper	22.0	2.2YR5.2/13.5	.560	.392	20.0	3.5YR5/9	.500	.392	18.0	3YR4.8/6.5	.458	.376
16	Avocado	22.0	2.5Y5.2/8	.465	.451	22.0	1.5GY5.3/5.8	.393	.449	22.0	6GY5.2/4.5	.346	.420
19	Ruby	15.0	8.35R4.5/16.5	.615	.340	12.0	7R4/13	.574	.324	11.0	3.5R3.8/10.5	.504	.305
18	Leaf	12.0	3.5GY3.9/5.5	.379	.472	12.0	10GY4/5.2	.309	.434	13.0	4.5G4.1/5.7	.267	.398
20	Chocolate	11.0	5YR3.8/7.8	.510	.395	11.0	5YR3.7/4.2	.420	.369	10.0	9.5R36/2.1	.370	.330
21	Bright Navy	0.6	1.5Y2.8/2.2	.385	.373	8.0	2.5PB3.3/9	.294	.302	0.8	5PB3.3/2.3	.244	.241
22	Forrest	0.7	1.5GY3/3.6	.384	.433	6.0	9.5GY3/2.5	.310	.374	0.6	3BG3/3.5	.252	.330
	Winsor & Newton Water Colors												
	Cadmium Yellow	56	4.5YR7/17	.557	.422	50	7.5YR8/15.5	.521	.444	48	9YR7.3/12.5	.492	.441
	Chrome Orange	38	1.9YR5.8/16.5	.567	.397	25	1.7YR5.5/14.5	.549	.387	21	1.5YR5/11.5	.540	.376
	Vermilion	20	8.5R5/18	.620	.350	17	9.2R4.6/13.5	.583	.353	15	7.6R4.4/11	.533	.344
	Alizarin Crimson	7	9.5R3.1/11.5	.614	.335	7	7.5R3/9	.554	.330	6	4.5R2.7/7	.487	.307
	Green Light	14	4GY4.2/6.3	.396	.489	15	9GY4.4/6.5	.319	.467	16	2.5G4.5/7.0	.273	.430
	Green Dark	8	10Y3.2/4	.396	.444	9	9GY3.4/3.75	.317	.408	9	7.25G3.4/3.75	.274	.361
	Cobalt Blue	6	7.5PB2.8/5	.244	.218	7	7.5PB3.1/10	.200	.152	9	7.5PB3.4/16	.175	.115
	Ultramarine Blue	4	8Y2.2/3.5	.275	.230	4	9PB2.2/12	.203	.127	4	4PB2.4/14	.182	.095

*Illuminant A.
**Illuminant Bs.

TABLE V.—Definition of Terms Used in Descriptive Naming of Colors.

I. Color Designations

Dominant color—ALL CAPS i.e. BLUE
Secondary color—Initial Caps or lower case i.e. Green or green
Composite color—(balanced-equal parts) ALL CAPS i.e. BLUE-GREEN
Method of designating influence of secondary color, beginning with dominant color and progressing to a balanced composite color.
BLUE—(Dominant Color)
BLUE—green cast
BLUE—tinged with green
BLUE green
BLUE-GREEN—(Balanced composite color)
These designations correspond to approximately two steps of Hue change on the Munsell Hue Circuit.

II. Sensation Expressions

Warm (warmth—less warmth) or Cool, Cold (colder)
The color gives this impression but evidence of an apparent definable warm, red, orange or yellow or cool-cold, green or blue color is not detectable to the extent where it can be definitely stated.
Light, lighter—Small degrees of sensation change.

III. PIGMENTATION—quantity, and characteristic
Vivid—colorful, intense, brilliant
Strong—colorful, concentrated, solid—(opposite of weak)
Medium—middle position between strong and weak
Pale—Definable tint of a color
Weak—diluted, thin, watery—(opposite of strong)
Grayed—quality of color reduced by the addition of gray
Dull—grayed to the extent where clear definition is difficult (opposite of clear, distinct, sharp)
Faded—loss of color, distinctness and brightness—lifeless
Deep—strongly pigmentated color, dense, low in value, no composition change
Dark—approaching black; extremely deep color

NOTE: Where the reflectance of the color is known its value becomes of importance in stating the absolute lightness or darkness of the color. Used in connection with the Dominant Color and Pigmentation it is helpful in conveying the colorfulness of the color.

matched under the "deluxe" warm fluorescent. Under "standard" warm a purplish cast develops and the color fades somewhat.

Red and blue purples (7, 11 and 21) under incandescent, these change quite markedly. The colors are not only made warmer, but they also swing toward the color of the illuminant; 7 is now orange Pink, 11 is Gray having a warm yellowish cast, and 21 is BLUE-gray low in color. The following changes under the "deluxe" warm lamp were noted. The orange Pink (7) remains the same. The Gray-warm (11) loses its yellowish cast to take on a purplish cast. The BLUE-gray is matched except that it shows a slight red increase. Under the "standard" warm lamp 7 is still ORANGE pink, dull, but 11 becomes BLUE pink pale, and 21 becomes Red PURPLE.

Browns (17, 13 and 20). The incandescent filament lamp warms and also changes these colors. Color 17 is now ORANGE-RED, 13 is YELLOW-red brown, and 20 Yellow RED BROWN, warm. Under "deluxe" warm 17 the color is maintained, but slightly less red. Color 13 also holds except it grays somewhat, and 20 is also held with less warmth. These same colors under "standard" warm are about the same as when illuminated by the "deluxe" warm lamp except that the ORANGE-Red of 17 changes to ORANGE-YELLOW dull.

The grays (5, 8 and 14) under the incandescent filament lamp all show the effect of this illuminant which is yellow-red. Color 5 changes from GRAY-yellow to Yellowish GRAY; 8 changes from GRAY-warm, to Reddish-GRAY, warm; while 14 changes from GRAY, blue cast, cool to a Warm GRAY.

Under the "deluxe" warm 5 shows a light greenish cast, 8 becomes warm GRAY no reddishness, and 14 develops greenishness. Under "standard" warm there is a slight greenish cast for 5, color 8 develops a slight pinkishness and weakens, and 14 is a pinkish GRAY.

The color rendition of Winsor and Newton artists colors under "deluxe" and "standard" cool and warm fluorescent lamps, when compared with artificial "daylight" and incandescent filament respectively, are now discussed. By referring to the second section of Table I the color appearance of each of these colors may be noted under the two reference illuminants indicated. Table II-B shows the color rendition qualities of the "deluxe" and "standard" *cool* fluorescent lamps when viewing the Winsor and Newton colors. Those colors which are inherently in the red family are stepped up slightly in red. The greens are yellowed slightly. The two blues are affected in accordance with their red or purple content. The blue without much purplishness becomes more purple, while the blue that is purple, lightens and weakens. The "standard" cool with its lower red content weakens the yellow and turns the orange yellow brown, while the red orange turns a light brown etc. The two blues are less purplish than they should be.

By referring to Table III-B the color rendition qualities of the "deluxe" and "standard" *warm* fluorescent lamps may be further examined when compared with the incandescent filament lamp. Here the "deluxe" warm lamp makes moderate changes throughout until we examine the Cobalt Blue (Blue, Deep). The shift is to Red PURPLE. The "standard" warm lamp greens the yellow and switches the ORANGE RED to YELLOW Brown, the Brown RED is now just BROWN. The Cobalt Blue is again changed to Red PURPLE, and the Ultramarine, BLUE Purple, is reproduced as well as it is under the incandescent or "deluxe" warm fluorescent.

Summary

Both the "deluxe" fluorescent lamps, i.e., *cool* white and *warm* white show great improvements in their color rendition characteristics, when compared with the "standard" cool and warm fluores-

cent lamps respectively.[3] The cool "deluxe" fluorescent lamps provide a very practical source of light for interiors, where good color rendition and a cool white light-source is desired. Its light is slightly warmer than noon sunlight alone. The data in the Tables from I to III should be studied and the analysis under the subhead "Color Rendition" reviewed for indications to answers to specific questions.

It has long been recognized that the light from incandescent lamps modifies the appearance of colors. The degree of these changes has not been too widely recognized or systematically set forth. Table I shows how powerful the color of this illuminant really is. Out of the thirty colors studied, almost all pulled toward yellow-red, and colors which in themselves are in the yellow-red series are increased in chroma. Colors such as Vermilion, Alizarin Crimson and Cobalt Blue do resist this switch to a high degree.

Our use of filament lamps has been associated with color changes. These changes have not provoked any unusual reaction except for the medium and light blues and blue-greens. The relative lack of blue in the incandescent filament lamps has been known. Interior designers and others experienced in these matters, therefore, have not employed these blues very widely.

Just how well the light from incandescent filament lamps is simulated with the "deluxe" and "standard" warm white lamps, may be observed from the data in Tables IIIA and the analysis under Color Rendition. Specific colors indicate the nature and extent of the departures from the incandescent filament lamp. The "deluxe" warm fluorescent lamp shows a remarkably good parallel to the incandescent filament lamp throughout the colors observed.

3. Barr, A. C.: "Color Properties of a Simplified Line of White Fluorescent Lamps," ILLUMINATING ENGINEERING, Vol. XLV, No. 1, p. 37 (January 1950).

Department Store Show Window

Two long show windows line the entrance to Irvin's Department Store, Baltimore, Md., each window utilizing a different lighting treatment. The north window (right) is done with a louverall ceiling with fluorescent reflector strips run continuously 12 inches between rows. Supplementing the louverall ceiling are 17 150-watt R40 spotlamps in recessed units. The recessed portion of the housing is exposed to view and is painted green, silhouetted against a corrugated aluminum background. The units are spaced on 18-inch centers just inside of the plate glass window.

The left window is treated with 21 200-watt reflectors with a parallel louver. The equipment is recessed in the ceiling. In addition, there are seven 4-light 20-watt recessed louver bottom troffers. (Photo: courtesy of Lighting Service Department, Consolidated Gas Electric Light and Power Company of Baltimore.)

Light for Aircraft Inspection

By G. E. SOLLEY

COLOR played an interesting part in the solution of the lighting problem presented in the inspection area of the Piper Aircraft Corporation, Lock Haven, Pennsylvania. The plant is approximately 12,000 square feet in size, and divided into two inspection areas — one for wings and tail assembly, and one for the airplane fuselage. The airplane parts are moved through the plant on overhead rails, on the order of an assembly line conveyor, with ten inspection stations along each conveyor.

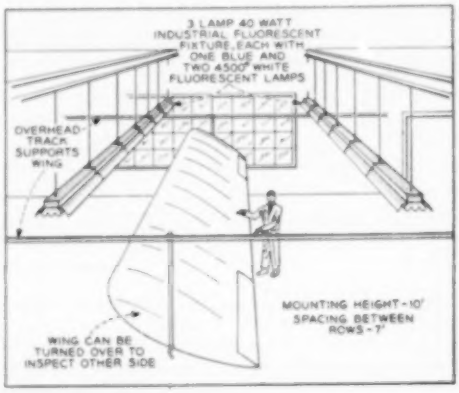
The superintendent of the plant told us that the airplane sections were crated at different parts of the factory and shipped to various cities in the United States. There they were assembled and in a great many cases the wing and tail assemblies did not match the fuselage. Color of light was an important factor in the lighting problem.

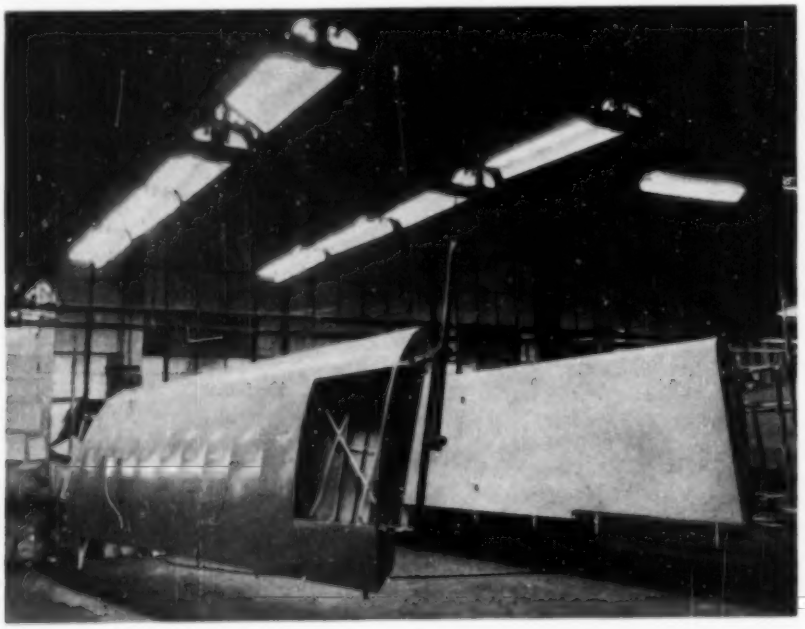
Fluorescent, mercury and incandescent lighting had all been tried individually and in combinations, with rather unsatisfactory results.

A trial area was suggested for one inspection station, in which we installed two continuous rows of three-lamp, 40-watt, industrial fluorescent luminaires, seven feet between rows, at ten feet mounting height.

Each luminaire contains one blue and two standard cool white fluorescent lamps. This combination of lamps was plotted on the I.C.I. color mixing nomograph and checked, as to resultant color, on the I.C.I. Chromaticity Diagram. This combination of lamps was tried and found to be very satisfactory.

The trial installation has since become a permanent installation and all the lighting is in the process of being changed in the inspection area. Each inspection station, where the new lighting has been installed, now has 80 footcandles on the working plane.





MR. SOLLEY is with the Pennsylvania Power & Light Co., Williamsport, Pa. His solution of the lighting for aircraft inspection was a runner-up in the contest for "My Most Interesting Job," conducted by the Eastern Pennsylvania Chapter.

The Illumination at a Point from an Industrial Fluorescent Luminaire

By ROBERT D. BURNHAM

Industrial type fluorescent luminaires are often arranged so that the illumination produced varies greatly from point to point, and the value of the system cannot be judged from average illumination. Herein, a method is set forth to determine the approximate illumination at any particular point beneath an industrial type fluorescent luminaire. A semi-graphical method is proposed to reduce laborious calculations to a minimum.

THE ILLUMINATING engineer has been able for some time to calculate the approximate illumination at a point from most incandescent luminaires, the basic assumption being that the luminaire is considered a point source of light. With the intensity distribution curve and the proper application of the inverse square law the approximate direct illumination at a point can be calculated.

With the advent of the fluorescent lamp the extended source became common. The inverse square law does not hold true in most cases. Therefore, the formulas for the illumination from extended sources must be considered when dealing with fluorescent luminaires.

With an extended source, as with the point source, the illumination is a direct function of the intensity of the particular luminaire. The intensity distribution curves of most luminaires available today are asymmetric, and it becomes difficult to handle them mathematically. Therefore, the expression for the illumination becomes unwieldy. However, if the intensity distribution is symmetrical and follows a definite law which can be expressed mathematically a satisfactory equation for the illumination at a point can often be written.

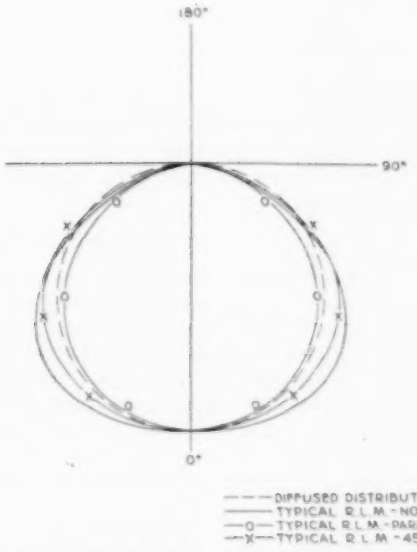


Figure 1. Comparison between a perfectly diffused intensity distribution and the intensity distribution curve of a typical R.L.M. fluorescent luminaire.

The equation for the illumination at a point may be determined if the intensity distribution solid is a sphere and positioned as shown in Fig. 1. This is a perfectly diffused distribution. Notice that the distribution solid for a typical R.L.M. type fluorescent luminaire approaches a sphere (Fig. 1). This suggests a comparison between the industrial fluorescent luminaire and a theoretical strip source with a diffused distribution.

Theoretical Framework

Consider a strip source of light. If this line source has a perfectly diffused distribution and the width of the strip is small compared to $(h^2+V^2)^{\frac{1}{2}}$ the following equation can be written.

$$E_p = \frac{I_o V^2}{2(h^2+V^2)}\left[\frac{L}{h^2+V^2+L^2} + \frac{1}{(h^2+V^2)^{\frac{1}{2}}}\tan^{-1}\frac{L}{(h^2+V^2)^{\frac{1}{2}}}\right] \qquad \text{Equation 1}$$

E_p the direct illumination at a point P. The point being in a plane parallel to the plane of the strip source.

I_o the maximum intensity per foot of the light source.

L the length of the strip source from plane ZX to one end of the strip measured in feet (see Fig. 2).

MR. BURNHAM is a lecturer and lighting consultant with the Chicago Lighting Institute, Chicago, Illinois.

V the distance in feet between the plane of the strip source in which point P lies (see Fig. 2),

h the distance in feet from plane ZY to the point in question.

The illumination depends on the maximum intensity per foot, and the relative position of the point with respect to the source. So Equation 1 may be modified:

$$E = I_c K \qquad \text{Equation 2}$$

Where

$$K = \frac{V^2}{2(h^2+V^2)}\left[\frac{L}{h^2+V^2+L^2} + \frac{1}{(h^2+V^2)^{\frac{1}{2}}}\tan^{-1}\frac{L}{(h^2+V^2)^{\frac{1}{2}}}\right] \qquad \text{Equation 3}$$

I_c is a property of the particular light source, and K is a factor depending on the relative position of the point in question with respect to the strip source. The total length of the luminaire may appear in K as a limiting factor.

Since Equation 1 is rather long and inconvenient to work with it has been modified as shown in Equation 2. K is expressed in Equation 3. For convenience Equation 3 has been plotted in the following five graphs, enabling a rapid determination of K, and by using Equation 2 one can determine the illumination at a given point.

Strip Source Compared with Fluorescent Luminaire

The foregoing method is for a theoretical perfectly diffused strip source. This method may be applied to any strip source as long as the intensity distribution approaches a sphere. However, the illumination will be an approximation rather than being exact. Many direct fluorescent luminaires may be considered as a good approximation of such a strip source. Preliminary investigations show that with a typical R.L.M. fluorescent luminaire the error encountered is within the limits usually encountered in lighting design.

This method renders only the direct illumination at a point and neglects interreflections. Therefore the illumination at the point may be slightly more than calculated due to the light reflected from the surrounding surfaces.

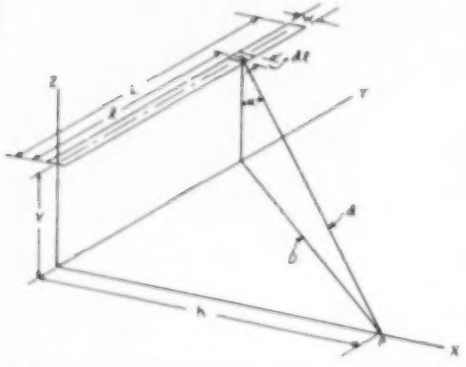


Figure 2. Physical arrangement considered upon the development of equation one.

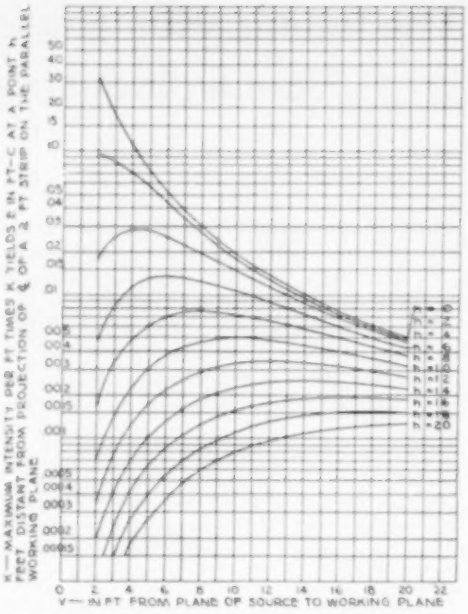

K — MAXIMUM INTENSITY PER FT TIMES K YIELDS E IN FT-C AT A POINT h FEET DISTANT FROM PROJECTION OF ½ OF A 2 FT STRIP ON THE PARALLEL WORKING PLANE
V — IN FT. FROM PLANE OF SOURCE TO WORKING PLANE

Figure 3. Results of calculations from equation 3 for a strip source have been plotted here for $L = 2$ feet.

Example Problems

Now consider a typical problem. In Fig. 8 a ten-foot strip source is considered. The illumination is desired at point P twelve feet below the unit, four feet out, and two feet from the end of the unit (see Fig. 8). The total illumination from this light source is the arithmetic sum of the illumination provided by the two-foot strip and that provided by the eight-foot strips. Therefore, they are calculated separately and added together giving the proper illumination.

From the photometric data for this unit the maximum intensity can be determined. Considering it to be 2500 candlepower, then the maximum intensity per foot (I_c) becomes 250.

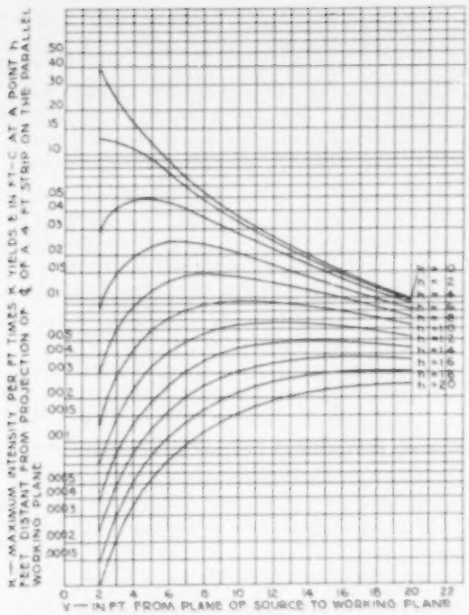

K — MAXIMUM INTENSITY PER FT TIMES K YIELDS E IN FT-C AT A POINT P, FEET DISTANT FROM PROJECTION OF ℄ OF A 4 FT STRIP ON THE PARALLEL WORKING PLANE
V — IN FT FROM PLANE OF SOURCE TO WORKING PLANE

Figure 4. Results of calculations from equation 3 for a strip source have been plotted here for $L = 4$ feet.

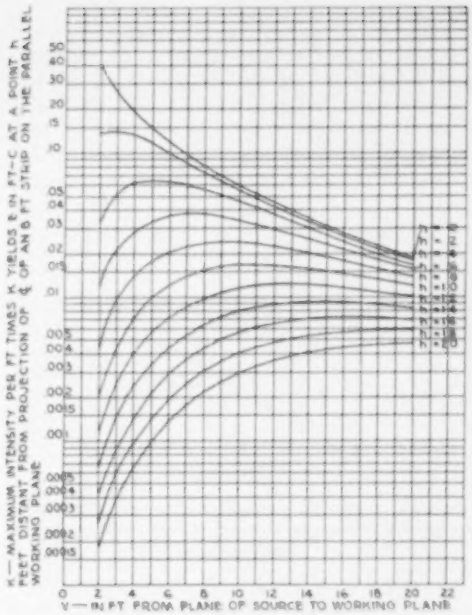

K — MAXIMUM INTENSITY PER FT TIMES K YIELDS E IN FT-C AT A POINT P, FEET DISTANT FROM PROJECTION OF ℄ OF AN 8 FT STRIP ON THE PARALLEL WORKING PLANE
V — IN FT FROM PLANE OF SOURCE TO WORKING PLANE

Figure 5. Results of calculations from equation 3 for a strip source have been plotted here for $L = 8$ feet.

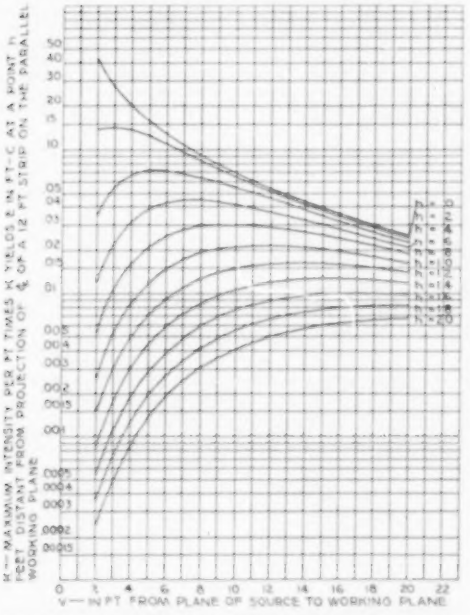

K — MAXIMUM INTENSITY PER FT TIMES K YIELDS E IN FT-C AT A POINT P, FEET DISTANT FROM PROJECTION OF ℄ OF A 12 FT STRIP ON THE PARALLEL WORKING PLANE
V — IN FT FROM PLANE OF SOURCE TO WORKING PLANE

Figure 6. Results of calculations from equation 3 for a strip source have been plotted here for $L = 12$ feet.

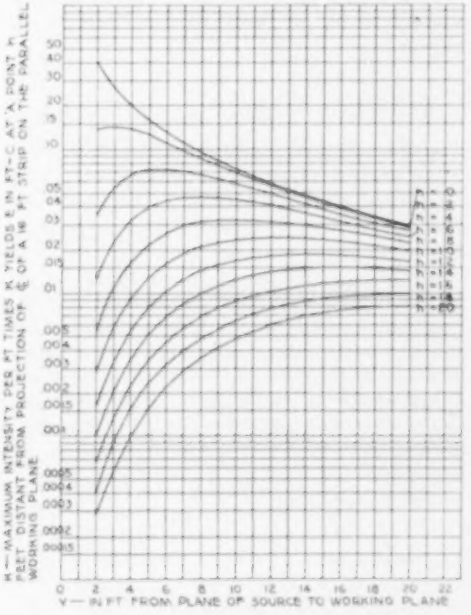

K — MAXIMUM INTENSITY PER FT TIMES K YIELDS E IN FT-C AT A POINT P, FEET DISTANT FROM PROJECTION OF ℄ OF A 16 FT STRIP ON THE PARALLEL WORKING PLANE
V — IN FT FROM PLANE OF SOURCE TO WORKING PLANE

Figure 7. Results of calculations from equation 3 for a strip source have been plotted here for $L = 16$ feet.

Figure 8. Figure for example problem one. Illumination at point *P* is considered from a 10-foot industrial fluorescent luminaire.

$L_1 = 2$	$L_2 = 8$
$V = 12$	$V = 12$
$h = 4$	$h = 4$
$K_1 = .011$	$K_2 = .036$

K_1 is determined from Fig. 3, and K_2 is determined from Fig. 5. Now Equation 2 may be employed.

$$E_1 = I_o K_1 \qquad E_2 = I_o K_2$$

$$E_T = E_1 + E_2 = I_o K_1 + I_o K_2 = I_o [K_1 + K_2]$$

$$E_T = 250 [.011 + .036] = 12 \text{ footcandles}$$

The illumination at a point off the end of a strip source with a diffused distribution can also be calculated. In Fig. 9 a typical problem is pictured. The length of the luminaire is six feet.

If it is found from the photometric data that the maximum intensity is 1800 candlepower, then the maximum intensity per foot becomes 300. The illumination under this arrangement is the illumination which would be produced by an eight-foot source minus the illumination provided by a two-foot source. One end of the strip is considered directly above the origin in each case. The equivalent of a six-foot strip source positioned as is shown in Fig. 9 is obtained.

$L_1 = 8$	$L_2 = 2$
$V = 9$	$V = 9$
$h = 12$	$h = 12$
$K_1 = .011$	$K_2 = .0032$
$E_1 = I_o K_1$	$E_2 = I_o K_2$

$$E_T = E_1 - E_2 = I_o K_1 - I_o K_2 = I_o [K_1 - K_2]$$

$$E_T = 300 [.011 - .0032] = 2.3 \text{ footcandles}$$

Now this method can be checked against an actual luminaire. This unit is an open end, industrial luminaire* employing two 40-watt fluorescent lamps. The maximum intensity (intensity at zero degrees) is 1140 candles. Since this unit is approximately four feet long, the maximum intensity per foot becomes 285 candles. If a point is considered ten feet below the center of this luminaire and four feet out, the illumination can be calculated as follows:

$L = 2$	
$V = 10$	$E = 2 I_o K$
$h = 4$	$E = 2 \times 285 \times .0145$
$K = .0145$	$E = 8.27$ footcandles

Under laboratory conditions the illumination at this point was found to be 8.0 footcandles. The error encountered under the above conditions is 3.8 per cent.

For problems where the luminous strip length is different than those expressed in the graphs, Equation 1 may be employed. The lengths (L) in the graphs have been selected as the lengths of the more popular fluorescent lamps and their multiples.

Conclusion

The typical industrial fluorescent luminaire is assumed to be a strip source with a perfectly diffused distribution. Therefore, any means of calcu-

*Westinghouse Electric R.L.M. direct fluorescent luminaire curve file No. 256787.

Figure 9. Figure for example problem one. Illumination at point *P* is considered from a 6-foot industrial fluorescent luminaire.

lating the illumination of a point from a theoretical strip source may be applied to an industrial luminaire.

The equation for the illumination at any particular point below a strip source is considered. A portion of this equation is plotted so that calculations may be kept to a minimum. This semigraphical means of determining the illumination may be adapted to each individual luminaire. The distribution curve shows how closely the curve will approach a circle or the distribution solid, a sphere, giving a general indication as to the error to be expected from assuming the luminaire to be a strip source with diffused distribution. The maximum intensity may be determined from the distribution curve. This is of value since the illumination is directly proportional to the intensity per foot.

The illumination determined by this means is an approximation of the actual illumination. It is the direct illumination only and neglects all light being reflected from any surface other than the reflecting surface of the luminaire.

The author desires to express appreciation to Professor J. O. Kraehenbuehl for his counsel, and to S. K. Sanders for the preparation of the figures which appear in this paper.

References

1. Boast, W. B.: *Illumination Engineering*, First Edition, McGraw-Hill, New York and London, page 90 (1942).

2. Higbie, H. H.: "Prediction of Illumination at a Point from Source of Any Shape," ILLUMINATING ENGINEERING, Vol. 36, p. 79 (January 1941).

3. Wakefield, E. H.: "A Simple Graphical Method of Finding Illumination Values from Tubular, Ribbon and Surface Sources," ILLUMINATING ENGINEERING, Vol. 35, p. 142 (February 1940).

APPENDIX

Equation (1) has been published in two of the references cited (1. *Illuminating Engineering* by W. B. Boast, and "Prediction of Illumination at a Point from Source of Any Shape," by H. H. Higbie). For ready reference in connection with this paper, the first equation is derived as follows:

$$dE_p = \frac{I_p}{D^2}\cos\alpha\, dl \quad I_p = I_o\cos\alpha \qquad \cos\alpha = \frac{V}{D}$$

$$dE_p = \frac{I_o}{D^2}\cos^2\alpha\, dl \qquad D = \sqrt{h^2 + l^2 + V^2}$$

$$E_p = I_o \int_0^L \frac{V^2}{(h^2 + l^2 + V^2)^2}\, dl$$

$$E_p = I_o V^2 \left[\frac{L}{2(h^2 + V^2)(h^2 + l^2 + V^2)} + \frac{I}{2(h^2 + V^2)} \int_0^L \frac{dl}{(h^2 + l^2 + V^2)^2}\right]$$

$$E_p = \frac{I_o V^2}{2(h^2 + V^2)} \left[\frac{L}{(h^2 + L^2 + V^2)} + \frac{I}{\sqrt{h^2 + V^2}} \tan^{-1}\frac{L\sqrt{h^2 + V^2}}{h^2 + V^2}\right]$$

$$E_p = \frac{I_o V^2}{2(h^2 + V^2)} \left[\frac{L}{h^2 + L^2 + V^2} + \frac{I}{\sqrt{h^2 + V^2}} \tan^{-1}\frac{L}{\sqrt{h^2 + V^2}}\right]$$

Discussion — Development of A-C Fluorescent Lighting for New York City's Subway Cars

by E. W. Beggs and H. W. Graybrook*

H. H. HELMBRIGHT**: The authors have presented some very interesting data on equipment to supply alternating current for lighting on 600-volt d-c operated conveyances.

The first attempt to use alternating current for fluorescent lighting in subway service was made on the Metropolitan Transit Authority subway in Boston in July 1948. The device used was of such design as to classify it as a rotating inverter. This system provided 3-phase, 60-cycle current at about 36 volts. This, in turn, was stepped up through delta connected transformers to 600 volts a-c. Special lamp ballasts were then used to operate 72-inch slimline lamps at 300 milliamperes. This system has since been replaced with a thyrite controlled motor-alternator without a flywheel.

There is no question but what a satisfactory a-c power supply is needed for this type of fluorescent lamp application. It is hoped that the two systems now in use will prove satisfactory from the service performance standpoint. The application of the flywheel seems to be one solution for the carryover at rail gaps. Will the 3600 RPM machine speed, together with the heavy flywheel, result in rapid bearing wear? Has any difficulty of this nature been encountered thus far?

I am interested in learning whether or not any evidence of short lamp life has been experienced in service due to the apparent high current occuring in the lag circuit when the third rail shoe passes over fairly long rail breaks and the motor alternator output voltage drops.

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**General Electric Company, Nela Park, Cleveland, Ohio.

Also, what voltage was selected for the 100 per cent figure in Fig. 5?

The authors do not state the current at which the lamps are normally operated. Is this figure 200 or 300 milliamperes?

The statement that fluorescent lamps operate more efficiently on a-c rather than on d-c is open to question. Watt for watt, direct current operation is more efficient, so far as the lamp itself is concerned.

The authors make no mention of the overall efficiency of the a-c system over the present 600-volt d-c system. It would be interesting to learn if conversion losses in the motor alternator plus ballast losses offset the gain obtained through being able to operate hot cathode lamps at higher current values.

J. J. DUFFY*: The title of this paper, "A-C Fluorescent Lighting for New York City's Latest Subway Cars," is misleading. This system of lighting was used on one special ten-car experimental train only and not on the "latest" cars. All of the 760 new cars built by the City, with the exception of this ten-car train, use cold cathode lamps operating on d-c.

The third paragraph of this paper states "The use of standard hot cathode lamps would reduce the number of lamps and fixtures and the amount of power required for each car . . . ." This is not quite accurate. The number of lamps and fixtures required in these cars is determined primarily by the space available in the car for lamps. As indicated in the photograph, a continuous line of lamps is provided down each side of the car, consisting of eight 72-inch lamps on each side. A single 42-inch lamp is provided across each end of the car. While it is true that the other cars of this size built for the IND do have six additional lamps down the center of the car, the roof design of these ten cars made it impossible to use these center lamps. On cars built for operation on the IRT Division, the center lamps were used on some of the cars but again a change in the roof due to change in the ventilation system made the omission of the center lamps necessary.

The a-c lamps installed on these ten cars are operated at approximately 220 ma while the lamps on the d-c cars operate at a normal 110 ma. The increase in lamp current in the a-c installation does provide an increase in lumen output over the d-c system.

The paper states "Furthermore, with alternating current, it is practical to use special ballasts of high open circuit voltage or to provide a cold weather voltage booster transformer which could be designed for any ambient condition whatever. One such device per car would be adequate and could be arranged for simple manual push button control or, if desired, could be fully automatic." It should be understood that special ballasts, booster transformers, etc., were not used in this installation.

It should be remembered that this ten-car train was built as an experimental train and many of the features, including the a-c lighting system, must be regarded as experimental. Results obtained from such experimental equipment cannot be expected to be 100 per cent perfect in all cases. The motor alternator with its flywheel and the attempt to provide voltage and frequency regulation to very close limits through its control system have given some little trouble in operation.

It is probable that were future equipment to be designed and built, the experience gained from this experimental equipment would make possible the elimination of most, if not all, of the difficulties experienced when the equipment was first put into service. In fact, the adjustments and changes which have been made from time to time by the manufacturer have resulted in a very workable system.

The chief difficulty now experienced is in short lamp life. The lamps which have been used up to now have been practically standard production lamps and have given a life of only 3 to 6 months. Work is in progress to improve the lamps for this service and it is expected that eventually a satisfactory life will be achieved.

T. C. KUEHN*: Ever since our construction in 1938 of the "General Pershing" for the C. B. and Q. Railroad, the first passenger train to be equipped with fluorescent lighting throughout, the Budd Co. has been conscious of the higher efficiencies and more pleasing appearance of the fluorescent lamp for railway car interiors over the incandescent lamp. It was gratifying to learn, when we took the contract to build ten super-deluxe stainless steel subway cars for the New York City Board of Transportation, that fluorescent lighting would be one of the important innovations.

Beggs has clearly described the problems in connection with the design of a suitable power supply for this class of transportation equipment and their work will be a valuable reference for future installations of this nature.

It might be of general interest to add (as Mr. Duffy said) that the car was equipped with 16 72-inch T-8 slimline lights, arranged in two continuous rows of 8 lamps each running longitudinally in the high ceiling section of the car. At the short low ceiling sections at each end a 42-inch T-6 lamp was placed laterally. Fluorescent lamps were also applied to the side destination signs and the illuminated map. Gaseous discharge sterilamps were also employed for sanitizing the ventilating air system. These were placed in both the fresh air as well as the recirculating air streams.

It was a pleasure to work with the Westinghouse Company and the New York City Board of Transportation engineers during this installation which we feel is an important advancement in the progress of car-lighting.

*Board of Transportation, City of New York.

*Railway Equipment Division, The Budd Company, Philadelphia, Pa.

E. W. Bangs*: The comments made by Mr. Duffy of the Board of Transportation are especially important because he has charge of operations. Actually, it is true that the lamps lighted up promptly during the winter of 1949-1950 without a booster. However, areas where colder weather is encountered might need a higher voltage and if they do, the solution is simple.

Regarding lamp life, we have found that the lamps start too soon as the alternator comes up to speed. This causes them to run for a short time at low current which damages the cathodes. Low voltage cutouts or other arrangements will be provided to eliminate this difficulty.

As Mr. Duffy states, the system has been more or less experimental and, except for troubles with detail parts, has worked exceptionally well.

The apparatus which regulates the frequency and a-c voltage is of the static type with no moving or delicate parts — however, some switching is necessary during the starting period and during gap operations. This switching is accomplished automatically.

In reply to Mr. Helmbright, there is a higher current through the lag lamp as the machine slows down but we do not believe that affects lamp life appreciably. Low current values are more apt to hurt these lamps. The low voltage cutout is needed and will, of course, protect the lamps against high current as well.

The actual voltage value at 100 per cent in Fig. 5 was 410 volts based on tests of our 72T8 hot cathode lamps. The tests were run on only limited groups of lamps so I chose to show voltages in per cent. It explains, however, why our lamps started so well on the XF-23-A alternator last winter. We believe they will start promptly down to 0° F since the generator provides practically full voltage at almost all values of third rail voltage encountered.

The standard ballasts used operate the lamps at approximately 200 ma. This is held almost constant over a wide range of third rail voltage.

The question of a-c vs d-c efficiency is, of course, of great interest. The a-c ballast loss is 12 watts per lamp while the watts consumed in the d-c ballasting system is about the same as in the lamp itself so the net watts per lamp is 68 and the net lumens per watt for the lamps now used is about 19.8. The a-c lamp plus its ballast consumes about 50 watts and operates at a net efficiency of 35.4 lumens per watt. The efficiency of the type XF-23-A motor alternator at normal full load and normal d-c line voltage is approximately 63.5 per cent. If we include the watts consumed in the alternator the net lumens per watt is 22.5 for the a-c system. This is about 15 per cent better than the d-c system now used.

There has been no evidence of abnormal bearing wear in the motor alternator and with the use of an oversize capacity bearing under the flywheel, no trouble is anticipated other than normal wear and replacements.

*Author

Discussion — New Glass Developments in the Field of Illumination*

by W. W. Shaver

R. W. Morris**: *General* — In view of the high degree of mechanical strength of certain glasses, mentioned in the introduction to this paper, would it be practical to use glass rods or tubes to suspend fluorescent or filament lamp luminaires? During World War II, slender glass rods suitably fashioned by the Lamp Development Laboratory at Nela Park, were used successfully as suspensions for the concentric ring louvers of silvered bowl lamp luminaires used in some of the Nela Park offices.

High Silica Glasses — A question raised by Dr. C. D. Spencer of the Nela Park Lamp Development Laboratory:

Chemical tests have indicated that sodium can be leached from the surface of certain pieces of "Vycor" brand chemical ware by means of water at room temperature. The same test gives no indication for sodium when applied to "Pyrex" brand chemical ware. Is this behavior characteristic of all "Vycor" brand chemical ware?

Photosensitive Glasses —

1. Dr. Shaver's reference to photosensitive glass containing suitably angled parallel vanes suggests an application not specifically mentioned by him but in which this new glass might offer special advantages. I refer to its possible use as side panels of luminous-sided fluorescent luminaires. It would appear that any desired degree of crosswise shielding could be achieved by selection of the angle or spacing of the vanes; in addition, the fact that the panels would be mounted in a vertical or steeply slanted plane should minimize the collection of dust, thus insuring good maintenance characteristics.

2. What is the prospect of developing photosensitive glass having dark colored vanes or cells? This for lighting applications requiring luminaires of very low brightness above the shielding angle.

3. Would it be possible or feasible to use exposed but undeveloped photosensitive glass in lighting equipments that are subjected to high temperatures, the thought being that the partial (or complete) conversion of a latent image to visibility might serve as a warning of excessive temperature? Less easily visualized in specific

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**Nela Park Engineering Division, General Electric Company, Cleveland 12, Ohio.

detail, but perhaps more intriguing, is the question of using exposed but undeveloped photosensitive glass to produce dramatic effects during a lecture or demonstration. I recognize, of course, that if radiant heat were used to develop the glass, a very high concentration of energy would be necessary. With this in mind, the question arises whether it would be possible for such applications to start with black photosensitive glass to increase its heat-absorption characteristics.

R. D. Bradley*: This is a very interesting paper concerning more recent developments in the glass making art, all of which is quite interesting to people working in the illumination field.

While the use of diffused silica glass and other special purpose glasses is, undoubtedly, well known to the lamp manufacturing industry, it is rather novel to others in the lighting profession.

I will try to confine most of my comments to the use of the photosensitive glasses as the writer is more familiar with these glasses, having run some tests using these glasses in troffer type equipment for commercial lighting applications.

The louvering effect from this glass is extremely interesting. The louvering effect provides an easily maintained source of louvering providing 45-degree shielding with reasonable efficiency. When considering high angle brightnesses, however, the photo-light glass has the typical failing of most louvered fixtures of this class. The intrinsic brightness at high angles, such as 10 to 20 degrees below the horizontal is practically constant, and relatively high. Studies of glare factors indicate, of course, that it is quite desirable to have these high angle brightnesses rather low. It may be possible by the use of some other color of louver to reduce this brightness materially without materially injuring the inherent efficiency of transmission. The writer feels that this would be a very worth while bit of research, as the new louvering medium would then lend itself better to so called "low brightness" installations.

*Day Brite Lighting, Inc., St. Louis, Mo.

W. W. Shaver*: With reference to the questions raised in the discussion by Mr. R. W. Morris, it should be quite practical to use glass loads or tubes to suspend fluorescent or filament lamp luminaires. It would be necessary to work out a suitable design but the comparatively low load per suspension should not cause any particular problem in the use of glass tension units.

With regard to Dr. Spencer's question as to whether or not a sodium compound can be leached from the surface of Vycor brand chemical ware by means of water at room temperature, this is not a characteristic of this glass. Vycor brand glasses are very low in alkali content and have a high chemical durability.

The suggestion of photosensitive glass panels with suitably angled paralleled vanes as side panels of luminaires is a very appropriate one as this material should be excellent for the purpose. There are other photosensitive glasses such as the ones shown here in the form of photographic transparencies which develop dark colors after exposure. However, these glasses are considerably more expensive than the Fota-lite glass and the density of color is not as high as desired. Work on this problem is being continued with the objective of obtaining a glass suitable for low brightness applications.

The use of exposed but undeveloped photosensitive glass as a temperature indicating device would seem quite feasible provided that the temperatures obtained would be sufficient to develop the latent image. Such temperatures would have to be of the order of 450° to 500°C. The suggestion of black photosensitive glass to increase its heat absorption characteristics would have the disadvantage that it might be difficult to detect the development of the image in dark colored glass.

Mr. Bradley's comments point out the problem mentioned in the second last paragraph of Mr. Morris' discussion. The production of a dark vaned glass which would reduce high surface brightness of the louvers would be a very useful product with a variety of applications. As previously pointed out, work is in progress on this problem.

*Author.

Parade of Progress for Anniversary Issue

Alston Rodgers' memorable presentation of the 1949-50 Progress Report at Pasadena will appear in print for the first time anywhere in the January "anniversary" issue of Illuminating Engineering.

The report makes good reading fare for those who did not make the Pasadena Conference and for those who want their memories refreshed.

Mr. Rodgers and his Committee report on everything new in 1950 — from industry predictions right on through all phases of new developments in lamps, accessories, equipments, installations and the rest.

Lighting a Narrow, Low-Ceiling Store

LIGHTING OBJECTIVE: To provide comfortable general lighting and accent lighting on merchandise in wall niches and on the feet of customers.

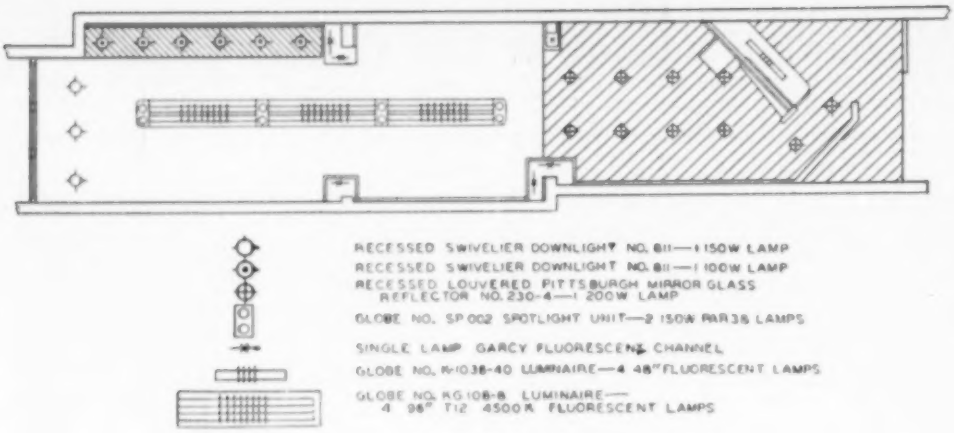
Installation at S. Pagel and Son, 44 East Main Street, Norristown, Pennsylvania; lighting designed by Deuane M. Hoffman, Philadelphia Electric Company.

General Information: This 72 x 13 x 9½ foot shop has several protruding structural members in side walls and ceiling, and is unusually long and narrow. Surface characteristics are as follows:

ceiling	white	84% RF
floor	gray	19% RF
sidewalls		
foreground	pink and white	68% RF
background	knotty pine	28% RF
soffit	gray	31% RF
niches		
foreground	dark gray	15% RF
background	dark maroon	14% RF
furniture	light gray and green	

(over)

A.I.A. File No. 31/14


RECESSED SWIVELIER DOWNLIGHT NO. 811—1 150W LAMP
RECESSED SWIVELIER DOWNLIGHT NO. 811—1 100W LAMP
RECESSED LOUVERED PITTSBURGH MIRROR GLASS REFLECTOR NO. 230-4—1 200W LAMP
GLOBE NO. SP 002 SPOTLIGHT UNIT—2 150W PAR 38 LAMPS
SINGLE LAMP GARCY FLUORESCENT CHANNEL
GLOBE NO. R-1038-40 LUMINAIRE—4 48" FLUORESCENT LAMPS
GLOBE NO. RG 108-8 LUMINAIRE—4 96" T12 4500K FLUORESCENT LAMPS

Plan View

Installation: See plan view caption for description of luminaires. After approximately 1200 burning hours the following lighting levels were obtained:

Women's Department (foreground)

General	
center	56 ft-c
near side walls	30 ft-c
Accent Areas	140 – 160 ft-c
Display Niches	43 – 46 ft-c
Entrance Downlights	64 ft-c

Men's Department (background)

General	
center	32 ft-c
near side walls	13 ft-c
Display Niches	30 – 35 ft-c
Cashier's Counter*	71 ft-c

Brightnesses are indicated below:

side wall (foreground)	15 ft-L
soffit	8 ft-L
floor	5 ft-L
ceiling	30 ft-L
luminaire side panels	75 ft-L

*Counter 36 inches above floor. All other footcandle readings on plane 30 inches high.

Lighting data submitted by George T. Anderson, Philadelphia Electric Company, as an illustration of good lighting practice and to aid in the design of similar installations.

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A Method of Testing and Evaluating Fluorescent Luminaires

By KURT FRANCK

In testing long fluorescent luminaires by conventional methods, it is often difficult to obtain the test distance necessary to get correct results; further, in evaluating photometric results for footcandle computations conventional methods become inaccurate for these long luminaires. The paper suggests a method to overcome these difficulties.

THE INTRODUCTION of fluorescent lamps of 6-foot and 8-foot length has made it necessary to make considerable changes in the methods of photometric testing and evaluating of fluorescent luminaires. It is a well known fact that in order to have the term "candlepower" be meaningful,[1] *i.e.*, in order to have the inverse square law apply for accurate point-by-point calculations, the photometric test distance should equal or exceed five times the largest dimension of the luminaire under test.

Other Methods

In practice this is quite difficult to obtain. If the fluorescent luminaire is to be placed for test in a position comparable to that of actual installation, the unit must be mounted horizontally. This makes it necessary to have a vertical distance of 40 feet available so that the photometer head, in most cases a photoelectric cell, can be placed 40 feet below the luminaire to measure the straight-down candlepower. With some sacrifice in accuracy this theoretically necessary test distance of 40 feet for 8-foot luminaires can be reduced to 20 feet and this is the limit to which, to the best of the author's knowledge, present testing of horizontally mounted luminaires has been carried in practice.

Since it is necessary to measure not only the candlepower directly below the luminaire but at all other angles, a 20-foot test distance calls for a 20-foot arm[2] on which the photometer head swings to reach all angles. This requires not only a good deal of space in the laboratory but also quite large photometric equipment of extremely rugged and mechanically well-balanced construction.

Another method[3] used at present is based on putting the luminaire under test in a vertical position so that the distance from test luminaire to photometer head can be in a horizontal direction, eliminating the need for 40-foot or even 20-foot ceiling height in the photometric laboratory. This method can be made to work quite satisfactorily from the standpoint of mechanically handling the large test distances but it suffers from the difficulties that the fluorescent lamp presents from the standpoint of temperature sensitivity. Luminous output and candlepower distribution of fluorescent luminaires change materially depending on whether the unit is mounted horizontally or vertically.

It is, therefore, necessary to go through an intermediate step[4] of measuring one particular luminous characteristic of the unit, say candlepower straight down, in horizontal position of the luminaire, as used in practice, and then in vertical position of luminaire as used in the test and to introduce the ratio of the two readings as a prorating factor from vertical luminaire position to horizontal position. This additional step of proration to convert from horizontal operation to vertical operation due to temperature sensitivity of the lamps is cumbersome and likely to reduce the accuracy of the test.

Test Evaluation

There is another point to consider; accurate and dependable photometric test results are not an end in themselves but a means to an end, namely, to calculate lighting results in advance of actual installation, be the calculations of a general type as that of the so-called flux of light method or be they of the more specific type in the so-called point-by-point footcandle computations.[5] Particularly with respect to the latter, it is important to bear in mind that what applies to test distance in photometric work also applies to the evaluation of photometric results in terms of footcandle values in installation; if the illumination in footcandles is to be computed from the candlepower distribution curve of an 8-foot luminaire, the results will be

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accurate only if the work plane or work point is located at a distance from the luminaire of at least five times the maximum dimension of the luminaire, i.e., for an 8-foot luminaire at 40 feet.

Here again the theoretically necessary distance of 40 feet can be reduced to 20 feet without much sacrifice in accuracy but even so, in practice most lighting installations for which fluorescent equipment is used do not deal with 20-foot distance from luminaire to work plane but are more likely to be in the range of 10 foot net mounting height of luminaire above work plane. Consequently, even when accurate photometric test information is available on, say, an 8-foot fluorescent luminaire, accurate point-by-point calculations of its performance cannot directly be made for installation conditions with mounting heights of luminaire above work plane of about 10 feet.

The problem of obtaining accurate performance values of long luminaires is thus a two-fold one: it applies equally to testing of luminaires in the laboratory and to evaluation of test results in the field when footcandle results are to be calculated from photometric test plots. It is not sufficient to provide by some method or other accurate photometric test results if then no provision is made to use these test results properly when they are applied to the practical evaluation of an actual installation.

Proposed Method

The proposed method described below aims at solving these two problems at the same time. The method consists of breaking down the long fluorescent luminaire into "elements" of shorter length, both for test and for evaluation, *i.e.*, computation of footcandle results from the test plots. The choice of element size depends on the degree of accuracy required; it will usually lie between 2-foot elements for greater accuracy and 4-foot elements for an accuracy sufficient for most installation conditions.

Assuming that the choice is made for 2-foot elements, the process then is to consider the long fluorescent luminaire, say of 8-foot length, to consist of four 2-foot sections to be tested separately and later to be evaluated separately for footcandle results on the work plane. Using again the axiom that test distance from luminaire to photometer head or net mounting height from luminaire to work plane should be at least five times the maximum dimension of the luminaire, it becomes evident that a 2-foot element meets practical testing and evaluating conditions quite well. Five times the length of a 2-foot element or 10 feet gives a test distance which can readily be realized in the laboratory with the test luminaire mounted horizontally corresponding to its final operating condition. Also, the 10-foot distance works out well for evaluating from photometric test plots the performance results of actual installations.

Stating the aims of the proposed method in different form it might be said that by breaking down a long luminaire into short elements we are in effect replacing the linearly extended luminaire by a series of point source luminaires at 2-foot spacings; both testing and evaluating of test results then proceed for these virtual point source luminaires in the standard manner long established for incandescent point source luminaires.

Procedure

In actual test practice there are quite a number of details that must be taken into account in the use of the "element" test method. Fig. 1 shows a longitudinal cross section of a typical fluorescent luminaire of 8-foot length. By breaking this luminaire down into 2-foot elements as shown in the figure, it can be seen that it divides itself into two end sections *e* and two center sections *c*. Output and distribution of elements *e* and *c* are not identical for several reasons: as far as the lamp is concerned there is the interference of the socket and of the end electrodes of the lamp in section *e;* further, the operation of the arc stream in the lamp is such that it runs brighter in its center portion in elements *c* than at its end in elements *e*.

As far as the luminaire is concerned the end element *e* of an individual unit has slightly less output than the center element *c* because of reflection losses from the endplate of the fixture. These are, of course, not present in the center section where the light must be taken into account which emanates from points of the lamp beyond the extension of the 2-foot element itself, as shown by rays *a* and *b* in Fig. 1. Further, in case of lens enclosed or louvered luminaires, there is usually a fixture

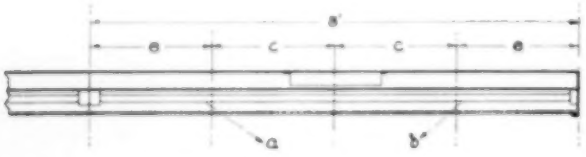

Figure 1. Longitudinal cross section of typical fluorescent luminaire showing breakdown into center sections and end sections of 2-foot length.

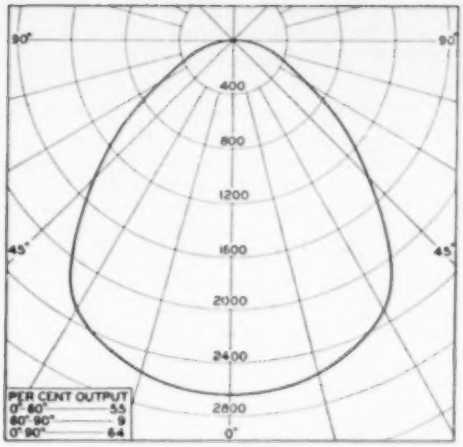

Figure 2. Candlepower distribution curve and output table of typical 8-foot fluorescent luminaire using two 8-foot slimline lamps.

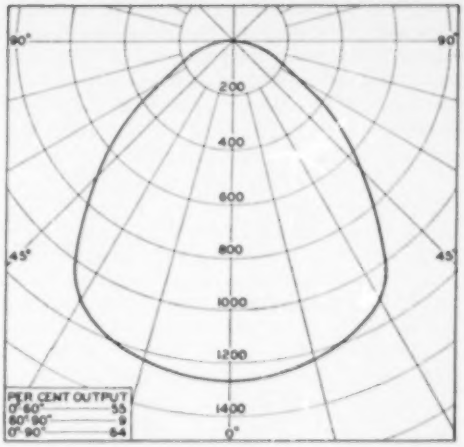

Figure 3. Candlepower distribution curve and output table of same optical assembly as shown in Fig. 2, but in 4-foot length and using two 4-foot 40-watt bipin lamps.

flange at the end of the luminaire which obstructs some light not obstructed in a center section.

Fig. 1 shows at its left end the extension of the individual unit into a continuous run. In many cases the end plate is then eliminated, again changing output and distribution conditions slightly.

These variations from end section e to center section c and from individual unit to continuous run must be taken into account in the testing of 2-foot elements. A practical test procedure is to get accurate test data on each individual element and then average center sections and end sections properly so as to end up with a test result of what can be considered a representative 2-foot element. Also, since the luminaire is broken down for test into element components, a similar course must be followed for the tests on the lamps alone which is an essential part of the complete test procedure. This must be done by proper shielding of the lamps to 2-foot length.

In practice, precautions must be taken in shielding sections of lamps and luminaire so as not to disturb the thermal operating conditions of the lamps which in turn would result in changes of luminous performance. When shielding the lamps to 2-foot length it has been found to be practical to use thin shielding vanes oriented at right angles to the lamps, the lamps passing through holes in the vanes. The portion outside of the vanes can then be shielded out at sufficient distance from the lamps so as not to produce undesired heating effects. In a similar way, sections of the luminaire must be shielded, always bearing in mind that the shields themselves must be far enough away from the luminaire so as to maintain proper thermal and luminous operating conditions.

Presentation of Data

After properly averaging center sections and end sections and weighting the slight differences between individual units and continuous runs, candlepower distribution and output values are then recorded as shown in Figs. 2, 3 and 4. By way of

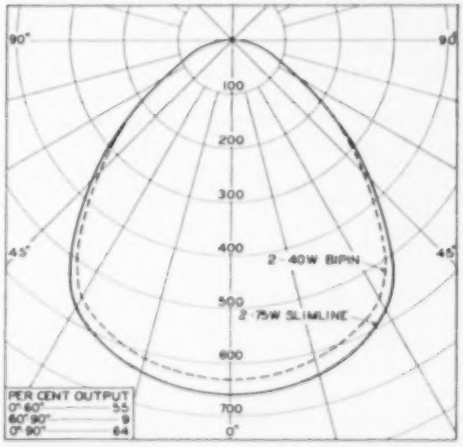

Figure 4. Candlepower distribution curve and output table of same optical assembly as shown in Figs. 2 and 3, but for a 2-foot element, using either two 8-foot slimline lamps (solid line) or two 40-watt bipin lamps (dotted line).

example, Fig. 2 shows the candlepower distribution of a prismatic lens unit using two 8-foot slimline lamps; Fig. 3 shows the performance of the same lenses in a 4-foot unit using the regular 40-watt lamps with bipin sockets; finally, Fig. 4 shows the results from a 2-foot element. It can be seen that the shape of the distribution curves and the relative output values in the different zones are identical for all three test plots of Figs. 2, 3 and 4. This is so because all three are based on properly averaged and weighted tests of 2-foot elements. However, the numerical values differ in accordance with the different lengths of the units and are adjusted for the difference of rated lumen output of 8-foot slimline lamp versus regular 40-watt lamps. This is the reason why in Fig. 4 two distribution curves are shown: one curve refers to the lumen rating of the 8-foot slimline lamp, the other to the lumen rating of the regular 40-watt lamp, as indicated in the figure.

The practical application of the test results of Figs. 2, 3 and 4 for the evaluation of actual installations is then proposed to proceed as follows: Figs. 2 and 3 provide a general picture of distribution and output of the luminaires for slimline and regular 40-watt lamp operation respectively. For the application of the flux-of-light method coefficients of utilization can be computed and used in the standard way. For more specific results, using the point-by-point method of calculation, the 2-foot element performance of Fig. 4 is employed.

Practical Application

Fig. 5 shows the need for the breakdown into 2-foot elements for accurate evaluation of the luminaire performance. Let us assume that regardless of what test method was used, the correct candlepower distribution plot of an 8-foot luminaire were available, recording, in effect, what the unit does if the test distance was in the neighborhood of five times maximum dimension of the luminaire. Fig. 5 shows this concept: an 8-foot luminaire is indicated in its longitudinal section with reference to a test point T, 40 feet below the luminaire, *i.e.*, a distance of five times the length of the luminaire. Center point S of end section e sends light to T at an angle f of 4.3° against the vertical.

Assuming that this luminaire were now used in an installation of, say, 12-foot ceiling height, work plane P-P at 3 feet above floor level would then be 9 feet below the luminaire as shown in Fig. 5. Center point S of end section e now sends light to work point W at angle n.

Angle n measures 18.3° against the vertical and thus differs considerably from angle f of 4.3° to which the photometric test of the whole 8-foot

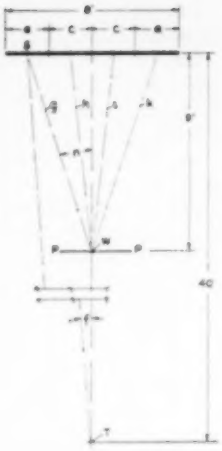

Figure 5. Angular relations of luminaire to test or work point for test distance of 40 feet versus typical net mounting height in practice of 9 feet.

luminaire applies. This means that if a correct candlepower distribution plot of the whole luminaire were used directly to figure illumination values on work plane P-P, the results would not be accurate since the light from various sections of the luminaire actually strikes the work plane at angles quite different from what is recorded on the candlepower distribution plot of the whole luminaire.

Here again breaking the luminaire down into elements of, say, 2-foot length solves the problem: by assuming the luminaire to consist of 2-foot sections with light coming to the work plane from the center point of each section, the proper angles to be read from the candlepower distribution plot can be readily established using rays g, h, i and k, as shown in Fig. 5. As stated above, this procedure is equivalent to breaking down the long fluorescent luminaire into a series of individual point source luminaires, small enough in size to obey the inverse square law and therefore permit accurate point-by-point calculations.

Scope

Again it is well to stress that this proposed method of evaluating the performance of long luminaires or continuous runs of fluorescent units applies regardless of the method by which correct candlepower distribution plots were obtained. It is convenient to have the distribution presented for 2-foot elements as shown in Fig. 4, but it is not necessary. If a correct distribution plot is available for, say an 8-foot unit, it can readily be converted into 2-foot elements by dividing all candlepower values by four and then proceeding with the suggested method of evaluation.

In the practical application of the proposed method of evaluating fluorescent luminaires of great length, it is evident that the use of small elements is of great advantage where the distribution from the luminaire is asymmetric or concentrated as, for example, in the case of specific luminaires for lighting vertical surfaces, blackboards, control boards, etc.[6] It is further evident that the choice of a 2-foot element may not always be the most appropriate to the task: if greater accuracy is required it may sometimes be advisable to go down to one-foot elements; on the other hand, for many practical applications, a 4-foot element may turn out to be the best choice as it will give results of good accuracy for net mounting heights of 10 feet and above.

Summary

In summary, the suggested method of dealing with long fluorescent luminaires or continuous runs of luminaires, both for photometric test and evaluation of photometric test results, consists of breaking down the unit into short elements for which the inverse square law holds true with normal test distances and mounting heights. The linearly extended luminaire is thus, in effect, replaced by a series of point source luminaires which can then be treated by standard methods of photometric testing and footcandle evaluation.

The author wishes to thank Mr. R. L. Smith for assisting in the preparation of the paper and for solving many of the technical problems encountered in making the proposed method work satisfactorily in practice.

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DISCUSSION

GEORGE R. BAUMGARTNER*: Mr. Franck has presented an interesting paper in his method of determining distribution and efficiency from 2-foot elements of longer luminaires using 10-foot test distances.

The proposed system may be particularly helpful in cases where space is limited and time required for testing is not of paramount importance. It appears to me that the time required to complete a test by this method is several times that necessary when present methods are employed, provided similar measuring devices are used.

It would be interesting to compare test results on a luminaire using 96-inch lamps with this procedure and measurements made at 20- and 40-foot test distances, viewing the complete source.

It is my understanding that this method applies principally to luminaires having direct components. A more detailed discussion and description of the baffling employed for the rest of the luminaires would be helpful.

G. A. HORTON*: It appears that the methods of testing and evaluating fluorescent luminaires as described by Mr. Franck would be somewhat confined to fixtures of the direct reflecting type applied where the walls and ceiling are dark as the point by point or footcandle method is most useful in determining the variation of illumination over a given area. However, this method cannot be used to advantage for luminaires of the general diffuse type since it does not take into account light on the working plane reflected from walls and ceiling. The lumen or coefficient of utilization method makes use of tables and certain data which have been accumulated through a large number of tests.[1] It is the method most often used. However, it gives only the average illumination in a room. The average illumination in a drafting room might be 50 footcandles, but if a draftsman were working in one corner where the illumination was only 4 footcandles, he would receive little consolation from the fact that the average was 50 footcandles. Both of these methods, therefore, have their applications.

The axiom that the test distance from luminaire to photometer should be at least five times the maximum dimension of the luminaire was derived from consideration of the lamps only. It was then extended to the luminaires themselves on the theory that what is a safe testing distance for the lamps should also be safe for the luminaires.

In a paper by Little and Salter[2] it was stated that for a 99.5 per cent precision, a distance of five times the maximum dimension of the lamp is quite satisfactory. A curve illustrating the theoretical departure from the inverse square law is shown. This was also confirmed experimentally for the four- and five-foot lamps.

Theoretically the correction is found by considering the lamp to be a cylinder radiating according to the cosine law and simplifying the result by assuming that the radius of the cylinder is small compared to the distance. The candlepower for $d = \infty$ is obtained by multiplying the candlepower measured at finite distance by the correction factor. The factor is given by

$$\frac{2l}{d\left(\tan^{-1}\frac{l}{d} + \frac{ld}{l^2 + d^2}\right)}$$

*General Electric Co., Nela Park, Cleveland, Ohio.

*Westinghouse Electric Corporation, Lighting Division, Cleveland, Ohio.

where l is the half-length and d is the distance.

When the lamps are placed in the luminaire and it effectively becomes part of the source, a somewhat different condition is presented and it may be that a ten-foot test distance would be sufficient for a fixture with four-foot lamps, particularly if the photometer is calibrated with the same lamps with which the test is run. This is a point that would bear investigation.

It appears that the shielding for testing luminaires in two-foot sections might become somewhat complicated in any but a totally enclosed type of fixture. The general diffuse type would be particularly difficult to shield.

It has been the experience of the writer of this discussion that the correction due to temperature sensitivity of lamps in a totally enclosed fixture when tested in a vertical position is usually zero, so that this causes no trouble when tested as already described in the literature.[3]

It is also pointed out that the I.E.S. Guide for Photometric Testing of Fluorescent Luminaires — 1948 recommends the use of the lumen method for reporting "Characteristics of Luminaire" on the Lighting Equipment Engineering Data Sheet. It is of course recognized that the lumen method may be applied to the composite candlepower curve obtained by Mr. Franck's method.

Mr. G. T. Winch of Wembley, England, states:[4] "Concerning the method used in photometering fluorescent luminaires, in view of the fact that in a majority of indoor installations they are operated at distances too close to the working plane to enable the illumination to be calculated from the polar distribution, we make measurements of illumination in one or more working planes. These measurements are made with visual or photoelectric types of illuminometers."

Cosine corrected portable photometers are available[5, 6, 7] and methods of utilizing the uncorrected photometers have been described in the literature.[8, 9, 10]

Mr. Franck should be commended for injecting some new thinking into photometric procedures where space limitations are a handicap.

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RAY P. TEELE*: Mr. Franck has presented a suggested method that overcomes some of the difficulties encountered in testing extended sources. His point that measurements made at a 40-foot test distance may lead to error in calculating the illumination when the mounting height above the working plane is only 10 feet is well taken. The treatment of 8-foot luminaires as a group of 2-foot sections for measurement and calculation means more work but the shorter test distance that is required and the closer approach to actual mounting heights should give results that more than justify the extra work in view of their greater significance when applied to an actual installation.

The space required for testing even a 5-foot luminaire is greater than is available in many laboratories. At the National Bureau of Standards we have a distribution photometer with a 25-foot photometric distance which allows the luminaire to be burned in the normal operating position. This apparatus is about as compact as it is possible to make with such a photometric distance. It is built in the form of a ferris wheel and the light travels from the luminaire to a mirror and is reflected across a chord to the photometer. The 25-foot photometric distance is thus available in a 20-foot circle and the entire distribution photometer occupies a space 22 x 8 feet with a 22-foot ceiling. It is obvious that similar equipment for a 40-foot test distance could not be accommodated in many laboratories. Franck's method would enable most laboratories to find space for the 10-foot distance that is suggested.

WILLIAM F. LITTLE**: The author's paper is very interesting and makes one ask for more. Before he completes his discussion perhaps he will answer a few questions, and outline somewhat more in detail just how he carries out his tests.

The idea of dividing the 8-foot unit into four two-foot units sounds simple, but what happens to the average distribution regardless of the finish on the vanes when there are in effect 8 end plates instead of 2? Vanes which touch the tube invariably leave mercury condensation rings if they are in contact or close to the tube. If they are not close to the tube then the curves for the four 2-foot sections are not the same shape as for the one 8-foot section. Will a 2-foot section with vanes give a true result for either the lamp alone or the luminaire? Surely it is not truly a measure of the 2-foot section without vanes.

It is difficult to understand how this method could be applied to a lens enclosed luminaire.

To measure four 2-foot sections is more than four times as arduous as measuring one 8-foot section. If

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each of the 2-foot sections is to be considered as a point source, then the vertical axis (photometric) of each section must be the axis of orientation. Such a goniophotometer would seem to require a complicated mechanical construction.

The idea of considering an 8-foot unit made up of four-point sources spaced 2 feet apart is intriguing. As the author states it is possible to apply the same thought to a single distribution, and if desired consider it to be 8 point sources spaced one foot apart, for that matter any number of point sources. This would permit the computation of illumination from the average curve for any mounting height. This, however, would seem to be an undue complication.

The I.E.S. Recommended Practice is to use three or five complete planes to establish the performance of a unit. It has become standard practice at ETL to measure planes parallel, normal and at 45° in all four quadrants. The procedure is to start each plane at 0° (nadir), proceed to the point where the photometric equipment cuts off the light, stop and return to 0° for the next plane. This is repeated until eight planes have been completed. The unit is then reversed as a transit is plunged, and eight additional planes are measured beginning at 180° (zenith).

This procedure multiplied by four would be time-consuming and seemingly unwarranted. The author mentions corrections which are necessary when standing the unit on end and in the other positions necessary when always rotating around a vertical axis. NOTE: (Rotating around a vertical axis keeps the unit in the same position relative to the heat currents for each distribution, in this way each distribution can be corrected to the normal hanging position.) It would seem that the corrections for each 2-foot section of an 8-foot unit would be quite as great if not greater than the simple correction for standing the unit on end. Two rather satisfactory methods have already been suggested for this process.* Incidentally it would help to understand this paper if the author would explain fully just how he standardizes his photometer, that is, how does he secure the relation between the unit operating normally and the lamps alone operating separate from the unit in free air. That has been by far the most difficult problem in connection with long fluorescent tube unit photometry.

HAROLD W. WILSON:** It is a well known fact that the point source of light is a most useful tool second, perhaps, only to the uniform, diffused, or torroidal brightness distribution source. As far as predictability of in-service illumination the above all lend themselves to mathematical treatment quite readily by means of the inverse-square law and the Calculus. Naturally, these methods will give exact answers limited in their numerical accuracy only by the accuracy of the available photometric data.

Mr. Frank has proposed a method of photometering and reporting the present-day linear sources which will give greater accuracy both to the photometric results and to the footcandle predictions. The method, as I understand it, would subdivide the longer lamps into smaller parts each of which may be referred to as a point source of light at the working distance of approximately ten feet. These subdivisions, which are to be separated from each other by a system of vanes and shields, will then be photometered individually. If there are "N" subdivisions of "X" feet each, this would require a minimum of 1.5N standard candlepower curves in the vertical plane, assuming 0.5N symmetrical divisions and a minimum of three standard candlepower curves per division. This means that for each additional subdivision at least three more candlepower curves in the vertical plane are required. Further, the length of time in test and interpretation of the test results would be increased almost on a proportionate basis. It would be interesting to know just how this would affect the price of having a fixture tested or doing it privately. Due to the separating vanes and shields I don't see how it would be possible to photometer from 0 to 180 degrees in the plane parallel to the lamps.

Assuming that the test equipment was calibrated to account for any errors due to the vanes and shielding used, which in itself is quite a problem if reproducibility of results is taken as a governing criterion, the resulting candlepower curves could be combined to give the complete fixture candlepower curve, as suggested by Mr. Franck. This curve is then to be used in conjunction with the Harrison-Anderson, or lumen, method of calculating average in-service illumination. But, what has happened to the accuracy due to the test? Zonal factors, for any size zone and to any desired degree of accuracy, may be computed and when multiplied by the average candlepower throughout the zone will give the lumens in that zone. The zonal lumens may then be used to

1) classify the fixture
2) calculate the fixture efficiency
3) determine what percentage of the total lumens are within the 0 to 40 degree zone.

By selection of room surface reflectance values, in the 30, 50, or 75 per cent class for ceilings and 10, 30, or 50 per cent class for walls, a room index is obtained and utilization factors computed. From this the coefficient of utilization for the fixture for a given set of room conditions is calculated. Then, by assuming a probable maintenance factor the average illumination is calculated. Throughout this procedure values are selected or classifications made either to the nearest value obtainable or purely arbitrarily taken. Since the overall accuracy is limited by the least accurate figure used it would seem that the initial test accuracy would very soon be lost due to the less accurate figures in subsequent calculations. Mr. Baumgartner in his recent paper (ILLUMINATING ENGINEERING, April 1950) states that at a test distance of 20 feet for an eight-

*Horton Baumgartner papers with discussion.

**Lighting Consultant, Southern California Edison Company, Hollywood, California.

foot luminaire, that the error is only 2.5 per cent. I don't see how the proposed method of testing can be justified on the basis of lowering the test error to say 1.5 per cent.

The author points out that for a ten-foot distance between luminaire and the reference plane the two-foot element may be taken as a point source in the inverse-square law to obtain the illumination at any point in the plane. It seems to me that if more brightness distribution data were available through the use of Calculus a much more accurate picture may be obtained, especially when continuous rows are being considered. Use of equations, obtained by Calculus, to calculate the illumination at a point due to the light coming directly from the luminaire in conjunction with the Inter-reflectance method, as suggested by Professor Parry Moon, to obtain the amount of illumination at the same point due to the light reflected from the ceiling and side walls will give a good idea of the results to be expected. In this way illumination design could be based on Brightness Engineering rather than on Footcandle Engineering.

One other point I would like to make is that in reference to subdividing an eight-foot luminaire into two-foot sections, Fig. 1, the author says, "Output and distribution of elements "e" and "e" are not identical . . ." and reasons are given for this. Yet, later in the paper it is stated "It is convenient to have the distribution presented for the two-foot elements, as shown in Fig. 4, but it is not necessary. If a correct distribution plot is available for, say an eight-foot unit, it can readily be converted into two-foot elements by dividing all candlepower values by four and then proceeding with the suggested method of evaluation." These two statements seem to conflict. It seems to me that the candlepower values for the eight-foot unit should be divided by something larger than four, say five, and prorating the center portions approximately 1.5 each, while the ends would only be 1.0 each.

Mr. Franck is to be congratulated on his fine paper and for recognizing the need for more accurate methods of predicting illumination at the time of a lighting design.

KURT FRANCK*: The author wishes to express his thanks for the kind words and comments made in the discussion of his paper.

As Messrs. Baumgartner, Horton and Teele point out in their remarks, the main reason for suggesting the test method described is that of space limitations in the testing laboratory: the proposed method permits accurate testing of extended fluorescent luminaires when only a 10-foot test distance is available.

Answering the questions of Messrs. Baumgartner, Little and Wilson on the test procedure in general, we should like to amplify the paper by briefly describing our own particular solution in line with the proposed method: in our test set-up the unit to be tested is mounted in horizontal position, that it, a position of final use at a test distance of 10 ft. above an arc-like structure which carries the photocell. By moving the photocell along this arc, any vertical angle can easily be measured at the 10-foot test distance; also, by moving the whole arc itself it is readily practical to make measurements at any lateral orientation and also to shift the reference point of the test from the center point of one 2-foot section to the center point of any other 2-foot section without changing the position of the unit itself.

Messrs. Baumgartner, Little, Horton and Wilson bring out the fact that details of shielding devices for the proposed test method were not adequately covered in the paper. In testing an enclosed type luminaire there are no vertical vanes placed between the sections, as that would obstruct light that belongs to the section being measured and might affect thermal conditions. Instead, the portion of the unit not being tested is baffled by horizontal black paper shields on the outside of the lenses.

In testing the lamps alone, we test but the one value at right angles to the axis of the tube in accordance with the test procedure given in the I.E.S. Method of Testing Fluorescent Lamps 6.2 (f). The lamp is divided up into the same number of sections as the unit by small cardboard vanes which are not required to touch the lamp since we are taking only one reading at right angles to the lamp axis. The part of the lamp not being read is also baffled by horizontal black paper shields several inches below the lamp so as not to upset thermal operating conditions, with the shields terminating at the cardboard vanes.

As far as evaluation of test results for practical footcandle computations is concerned, Mr. Wilson points out that an increase in accuracy as obtained by the proposed method would hardly be justified for the so-called lumen method of computation in which so many factors can only be approximate. However, as Messrs. Horton and Teele emphasize in their discussion, the proposed method of breaking down the luminaire into elements for accurate evaluation of test results is best applicable not to the lumen method but to the Point by Point Method of footcandle calculations. As mentioned in the paper, this is of particular advantage in the case of specific luminaires whose light distribution is asymmetric, as for instance, for inspection lighting, counter lighting, blackboard lighting.

* Author

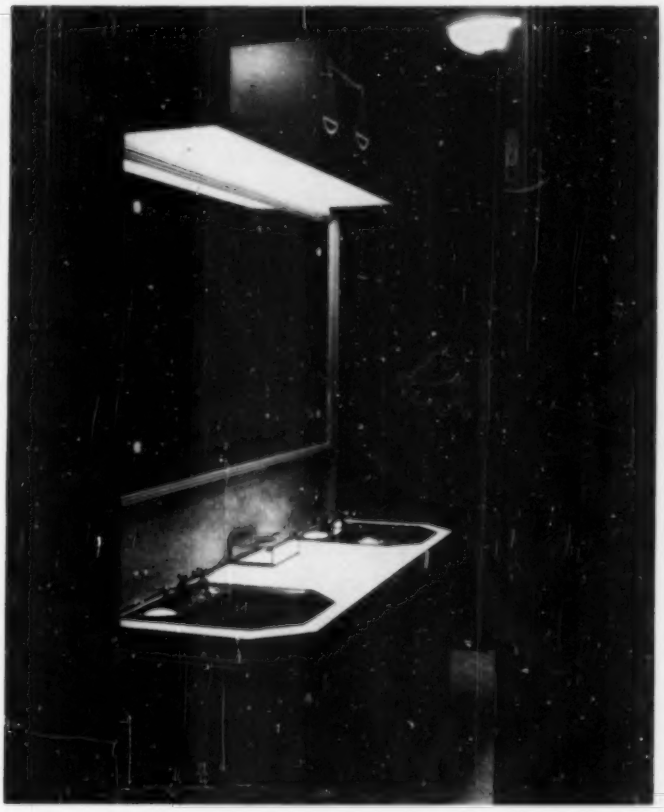
Reprints of "Contemporary Lighting for Modern and Traditional Interiors"

Attractively bound reprints of the complete I.E.S. Study Report, "Contemporary Lighting for Modern and Traditional Interiors," concluded in the November issue of ILLUMINATING ENGINEERING, will be available for distribution in single copies or quantities in January 1951. This 60 page publication covers the entire field of contemporary residential lighting and is an ideal lighting reference for architects, home lighting specialists and consultants, interior decorators and contractors. Light and power companies, manufacturers of residential fixtures and portables will find it an excellent promotion piece for their preferred lists which include these customers. Single copies up to 10 are priced at $1.00; quantity prices upon request.

Mirror Lighting Applications

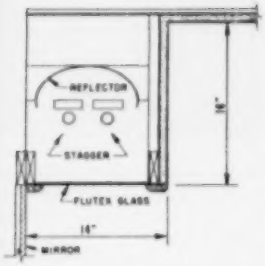
Installation "A," Lighting a Bathroom Mirror

LIGHTING OBJECTIVE: To provide adequate illumination at the mirror for shaving, make-up, and combing hair.



Installation at
Detroit, Michigan

Architect: L. G. Redstone
Detroit, Michigan



Cross section of bathroom mirror lighting

General Information: The large plate-glass mirror extends the complete length of the double lavatory unit, which measures 2' x 3' x 6'. The floor, cabinet-top and back splash are light gray (60% RF), and all other surfaces are dark maroon (13% RF).

Installation: A wooden box 16" high, 14" wide and 6' long is installed above the mirror as indicated in the drawing. This contains four 3500K fluorescent lamps (2 40-watt and 2 20-watt), staggered to eliminate shadows, and a simple-curved polished aluminum reflector.

Resultant illumination values with both mirror lighting and general lighting ceiling fixture in use are as follows:

Room average (horizontal plane 30" high)	18 ft-c
Cabinet top (center)	36 ft-c
Forehead of person standing before mirror	49 ft-c
Cheek of person standing before mirror	37 ft-c
Top of hair of person standing before mirror	53 ft-c

(over)

A.I.A. File No. 31/12

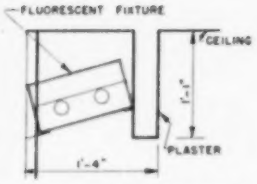
Installation "B," Lighting a Pier Mirror

LIGHTING OBJECTIVE: To provide adequate lighting at a full length dressing mirror.

Installation at
St. Clair Shores, Michigan

Architect: Walter Anika
Ann Arbor, Michigan

Builder: Bain and Anderson
Detroit, Michigan



Cross section of pier mirror lighting

General Information: The bedroom is 15′ x 13′ x 7′. Walls and woodwork are pinkish gray (50 per cent RF), the plaster ceiling is a grayed chartreuse (75 per cent RF), the carpet is light gray (34 per cent RF), the bed and chaise lounge are covered in deep red velvet, and the heavy linen draperies and slip covers are dark red, chartreuse and green. The modern furniture is bleached mahogany. The 6′ x 4′ plate glass mirror is used for full length viewing only. **Installation:** A flush-mounted type luminaire (Kirlin Company #240B) containing two 40-watt 4500K fluorescent lamps is recessed at an angle slightly less than 15 degrees in a cornice box above the mirror. The box is 4′6″ x 1′4″ and 13″ deep, finished outside in plaster painted to match the walls. The inner surface of the box and metal of the luminaire are painted a grayed white.

A 50-100-150 watt reflector floor lamps is used near the chaise lounge, and there are reading lamps (2 60-watt lamps each) on tables at either side of the bed.

Illumination and brightnesses after 100 hours operation were as follows with all lamps and mirror lighting in use:

Illumination on person 5′6″ tall standing 24″ from mirror:		Brightnesses	
Forehead	75 ft-L	Luminaire (glass)	375 ft-L
Cheek	35 ft-L	Wall	
Bottom of skirt	28 ft-L	directly beneath luminaire	90 ft-L
		average throughout room	7 ft-L
		Carpet	9 ft-L

Lighting data submitted by Mary Taepke, The Detroit Edison Company, Detroit, Michigan as illustrations of good lighting practice and to aid in the design of similar installations.

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Series XV 10-50

Annual Report of the General Secretary 1949-50

By A. H. MANWARING

ONE OF the responsibilities of the General Secretary is to present annually, a report for publication in the official journal of the Society. For this purpose reports have been assembled from the Society's Committees, Sections and Chapters, local groups, and representatives to other organizations, with the assistance of our Headquarters Staff.

During the early years of the Society, the General Secretary was able to "conduct the correspondence of the Society, keep full records, and perform such other duties assigned to him," with the help of an Assistant Secretary and one or two office girls. With the greatly expanded service now rendered by Headquarters, the General Secretary is assisted by twenty-one persons in the General Offices. He has reporting to him for the respective functions, the Executive Secretary with a staff of nine, the Technical Director with a staff of four, the Editor, and Advertising and Promotion Manager with a staff of four.

In the year just ending, the General Secretary has had to maintain "full records" of about 8,000 members, consisting of 7,057 individual, and 316 Sustaining Members. Individual files are maintained for every member, arranged by Sections and Chapters and in their respective grades. The General Secretary is required to send out bills for dues not later than October 10 each year. Delinquent dues payments are followed up in November, February, March, and May.

This year over 1200 new applications were sent to the General Secretary for processing, and review by the General Board of Examiners. In preparation for each of the ten meetings of the Board, the Executive Secretary secures all required references, records and local Board approvals. Notification of elections, membership cards, and dues invoices follow the acceptance of the Board's report by Council or Executive Committee. Special handling is given by Headquarters to nominations for election to grades of Member Emeritus and Fellow, the latter in cooperation with the Society's Board of Fellows. Arrangements are likewise made for the presentation of the Society's certificate to Members Emeritus and to Fellows. Immediately after the monthly elections, an analysis of the results is made and sent to the Membership Committee Chairmen. Upon receipt of the membership "pep" letter, the campaign results are mailed by Headquarters to the National Officers and to the officers of all Sections and Chapters.

In recent years the Society has been particularly conscious of the importance of keeping our Sustaining Members well-informed as to the Society's program. This has been accomplished by a number of special mailings from Headquarters to Sustaining Members, including a special report by the General Secretary accompanying a copy of a descriptive Society brochure.

The Treasurer and General Secretary of the Society are jointly responsible for the collection, safe-keeping and disbursing of the Society's funds in accordance with a budget recommended by the Finance Committee and approved by Council. With the Society operating under a tightly balanced budget of $200,000, the Officers must depend upon Headquarters for assistance in these important responsibilities. Headquarters collects and deposits all cash received. This, together with efficient handling of disbursements and bookkeeping records, has made possible prompt and complete monthly reports for the officers. Analyses of significant points, prepared by the Executive Secretary, are used by the Finance Committee and Executive Committee, during their July meeting, in planning the budget for the new fiscal year. The preceding monthly operations end each year with an inventory of the Society's stock of publications, and a final audit of all financial records, including a review of financial reports sent to Headquarters by all Sections and Chapters. Following the formal audit, the Executive Secretary prepares the usual reports for the Bureau of Internal Revenue.

There are 50 Sections and Chapters, and four Student Branches of the Society, which, together with over 200 local representatives, carry on programs of immediate and personal interest to a large part of the membership. Headquarters secures reports of these programs, conducts correspondence and circulation of program material necessary, and serves as liaison between the national committees and Section and Chapter representatives.

The Constitution now prescribes extensive procedures in the nomination and election of national, regional, and section officers. This involves first, the mailing of forms to all Sections and Chapters inviting suggestions of candidates fulfilling the requirements of several offices. Headquarters secures the official representatives named to the Board of Nomination. Each Board Member receives from Headquarters a detailed presentation of previous officers of the Society. After nomination of all slates, Headquarters prepares, mails the ballot, and arranges for the annual meeting of the Committee of Tellers, who assist in opening ballot envelopes and checking vote count. Upon completion, a special report is prepared by Headquarters with notices of election sent to all new officers.

Through his responsibility for Society finances, the General Secretary depends upon the Executive Secretary to collect all fees incident to Conference Registration. In recent years this has been accomplished largely through registration in advance of the Conference. This year again, registration for

Presented at the National Technical Conference of the Illuminating Engineering Society, held August 21-24, 1950, Pasadena, California.

the splendid Pasadena Conference was capably handled through Headquarters, requests for hotel reservations going promptly to the Conference Hotel Committee. Printing and mailing of the Conference Circular was carried out with guidance from our National Conference Committee and Executive Committee.

The Technical Office

The Technical Office has continued to serve the basic technical program of the Society.

Committee Program — The major activity is to work with the 69 technical committees in carrying on their studies and developing their reports. As a result of this joint endeavor six reports have been published this year: Recommended Practice of Daylighting; Recommended Practice for Library Lighting; Lighting for Canneries; Lighting for Bakeries; Lighting for Flour Mills; Lighting for Machining of Small Metal Parts.

Two testing guides have been finished — IES Guide for Outdoor Measurements; IES Guide for Photometric Testing of Floodlights of 10 to 160° Total Beam Spread, 1950.

Three residential reports have been completed: The Functional Visual Activities in the Home and the Location and Extent of Associated Areas to be Illuminated; Contemporary Lighting for Modern and Traditional Interiors; Recommended Levels of Illumination for — I. Reading Piano Music, II. Hand Sewing in the Home.

Two industrial reports will soon be available for use: Lighting for Steel Mills — Part I, Open Hearth; Lighting of Control Rooms.

There has been a phenomenal increase in interest in night lighting of sports. The new report entitled "Current Recommended Practice for Sports Lighting" has been completed.

In connection with this development of new tools for Society use the Technical Director has attended 63 committee meetings and has had 112 conferences with the chairmen and officers. The Office has assisted in revision and preparation of 15 reports involving over 1,200 pages of typing.

Data Sheets — Along the same line, the Technical Office has developed in finished form 24 Lighting Data Sheets for Series XV covering schools, residences, offices, industries, banks, and highways.

Research Program — In order to develop a sound base for the lighting structure of Recommended Practices, there must be knowledge of fundamental principles. To this end the Society set up the I.E.S. Research Fund. The Technical Director has been serving as Secretary. He has contacted educational institutions where there are specialized skills and laboratory facilities and arranged for research studies to be undertaken. His office keeps up an active stimulation of all of the work and maintains close contact with the Research Executive Committee and the Trustees. At present there are 12 projects under contract with another two being developed for early execution. Five have recently been completed, two of which were reported at the Pasadena Conference.

Technical Inquiries — Everybody writes to Headquarters for information. The Technical Office is on the receiving end for both members and the public at large. Inquiries for technical information have averaged five per day with a total of 1,243 for the year. Many of our papers, reports and Practices are brought to the attention of those in strategic position due to this service.

Talks — There must be support for our basic technical program, not only from outside organizations but also from our members who must be kept informed of the many interesting and helpful activities being planned. To this end the Technical Director gave 12 lectures last year in connection with his usual committee activities.

Other Organizations — Beyond the immediate work program, it is essential that the Society maintain good relations with other organizations having interests in illumination. It is necessary to build confidence in the work the Society is trying to do, and to clear up misunderstandings which many times lead to antagonism. The Technical Director is constantly striving to do this through active contacts with such groups. Last year these organizations were as follows: American Institute of Architects; American Public Health Association; Edison Electric Institute; International Ladies' Garment Workers Union; National Institute of Cleaners and Dyers; National Office Management Association; National Paint, Varnish and Lacquer Association; National Research Council, Committee on Night Visibility; National Council for Schoolhouse Construction; National Restaurant Association; National Society for the Prevention of Blindness; Ohio Optometric Association.

I.E.S. Research Fund*

Researches initiated over the past three years have progressed to the point where three completed and four progress reports have been made to the Research Executive Committee, and one has been processed and approved by the Trustees with recommendation for publication. Contracts for two more projects have been drawn up. Further proposals for research have been received and studied in anticipation of replenished funds.

The general research situation is favorable with considerable activity in the field of light, vision and the visual environment carried on in educational institutions under private and government sponsorship. One of the objectives as outlined in the Trust Agreement is the "stimulation of research in illuminating engineering and related fields." This the Fund is constantly striving to do in its contacts and operations.

During the year, the following men served as members of the Board with terms as shown:

Anthony W. Deller	To October 20, 1949
(re-elected to term of 5 years at Trustees Meeting, December 7, 1949)	
Alfred H. Nicoll	To October 20, 1950
J. W. Barker	To October 20, 1951
A. F. Wakefield	To October 20, 1952
Conrad Berens, M.D.	To October 20, 1953

Also serving (term of two years) as members of the Board were the following Presidents of the Illuminating Engineering Society:

R. W. Staud	To September 30, 1949
L. E. Tayler	To September 30, 1950
C. H. Goddard	To September 30, 1951
(New member as of October 1949)	

In accordance with the provisions of the Trust Fund action was taken by the Trustees to fill vacancies in the Executive Committee caused by the expiration of the terms of two mem-

*Abstracted from the Annual Report for year ending 12/31/49 presented to the Council April 1950.

bers. From the list of candidates presented by the Council of the Illuminating Engineering Society, two members were appointed, namely, R. M. Zabel and George R. Harrison (re-elected), for a term of three years. The members of the committee and their terms are as follows:

Ward Harrison	To October 20, 1950
Howard M. Sharp	To October 20, 1950
J. O. Kraehenbuehl	To October 20, 1951
Ralph M. Evans	To October 20, 1951
George R. Harrison	To October 20, 1952
R. M. Zabel	To October 20, 1952

By action of the Trustees at their meeting December 7, 1949, the following were elected to serve as officers of the Fund:

A. F. Wakefield, Chairman
A. H. Nicoll, Treasurer
C. L. Crouch, Secretary
Ward Harrison, Chairman of Research Executive Committee

The Research Executive Committee followed the work of the various projects through Chairman Ward Harrison and the Technical Advisory Committees. Since funds were not available little could be done in the way of accepting new proposals. However, there were sufficient funds to permit a reconsideration of the proposal, "Effect of Various Illuminants and Backgrounds on the Response to Color Stimuli," by Dr. Harry Helson who had returned from his Sabbatical leave and had offered to carry through the work at Brooklyn College which he had formerly proposed.

The Committee received a formal report from Miss Dorothy Nickerson who had carried on without expense to the Fund an elaborate series of calculations at the Department of Agriculture to specify the change of appearance and reflectance of 450 Munsell reference colors when viewed under four different illuminants including incandescent and fluorescent. This was acted upon favorably and transmitted to the Trustees for approval.

The Committee also received a report on the pilot study upon which to base the possibility of continued work at Tufts College on "Muscle Action Potentials as a Measure of Visual Performance Cost."

Chairman Harrison canvassed the projects in the fall and received progress reports from the following:

TABLE I.—Membership as of September 30.

	1945	1946	1947	1948	1949	1950
Members Emeritus	15	16	16	21**	26***	33****
Fellows	19	21	42	45	44	40
Members	766	986	1,201	1,406	1,521	1,610
Associate Members	3,332	3,878	4,335	4,908	5,048	5,005
Student Members	33	45	71	136	244	369
Total	4,156	4,946	5,665	6,516	6,883	7,057
*Wartime Dues Waived	421	220	.....	.....	.....	.....

*These members are included in the Total.
Fellows of the Society included ** 2, *** 5, **** 9.

TABLE II.—Gains and Losses in Membership During Year Ending September 30, 1950.

	Members Emeritus	Fellows	Members	Associate Members	Student Members	Total
October 1, 1949	26	44	1,521	5,048	244	6,883
Gains						
Elections	....	....	74	717	208	999
Reinstatements	....	....	19	80	5	104
Transfers	8	1	83	34	....	126
Total Gains	8	1	176	831	213	1,229
Losses						
Resignations	....	....	38	371	54	463
Dropped	....	....	34	393	....	427
Deceased	1	1	10	27	....	39
Transfers	....	4	5	83	34	126
Total Losses	1	5	87	874	88	1,055
Net Change	+7	−4	+89	−43	+125	+174
Total Membership as of September 30, 1950	33	40	1,610	5,005	369	7,057

Verification of Interreflection Formulae — Prof. H. S. Bull, University of Michigan

Measurement of Work Done by Extrinsic Ocular Muscles — Prof. Parry Moon and Dr. K. S. Lion, Massachusetts Institute of Technology

Flicker-fusion as a Measure of Visual Fatigue — Professors M. E. Bitterman and T. A. Ryan, Cornell University

Spatial and Temporal Characteristics of Retinal Inhibition—Dr. Glenn A. Fry, Ohio State University

Visibility Test Methods — Prof. C. L. Cottrell, Cornell University

Pavement Surface Reflectance — Prof. J. O. Kraehenbuehl, University of Illinois

As a result the Chairman and the Secretary of the Fund were able to compile a Monograph entitled "The I.E.S. Research Fund — What It Is and What It Has Done." This was offered to the Research Fund Committee of the Society which was formed to solicit contributions for the continuance of the Fund.

The Trustees held their annual meeting on December 7, 1949 for filling vacancies, electing officers, studying progress, and planning for the future. Chairman Wakefield has carefully followed activities of the Fund, has passed upon all expenditures and has been responsible for final acceptance of contracts. Treasurer Nicoll has exerted his usual care regarding the conservation and disbursements of the funds. The Trustees approved by letter ballot the report of Miss Dorothy Nickerson entitled "Munsell Reference Colors Now Specified for Nine Illuminants" for transmittal to the Publications Committee of the Society for possible publication in ILLUMINATING ENGINEERING. There have been no additions to the funds since 1946 but close liaison between the Fund and the Society indicates that an active campaign of replenishment is now underway.

Membership

The tabulations which form a part of this report record the membership of the Society by Sections and Chapters at the end of the fiscal year, as well as gains and losses in the various membership grades resulting in the final totals. As reflected in the graph of membership through the years the growth from 6,883 to 7,057 members continues the rise in membership which has been characteristic since the mid-thirties. A large part of the credit for this continued growth goes to the National Membership Committee which was under the capable direction of Garlan Morse, Chairman, assisted by James H. Hull, Vice-Chairman, who ran the Section and Chapter Member-

ship Campaign, and George Bogard, Vice-Chairman, who concentrated on the Local Representatives.

The quotas for the 1949-50 Section and Chapter Campaign were set up on the same basis as they were for the previous year; namely, a 20 per cent gain for all grade members of Sections and Chapters less than three years old, and 12½ per cent for those over three years old. The total dollar prizes for outstanding performances were increased slightly this year, but divided equally between winners of total new members and winners of Member grade only activities.

Considerable credit should be given to the first eleven Sections and Chapters which had a total assignment of 139 new members and have an accomplishment of 271, or 132 above their goal. Although some of the first eleven are relatively new Sections or Chapters, this group as a whole shows that interest in the Society can be had with effort on the part of the individual groups.

Prize winners in the two parts of the campaign, together with the respective Membership Chairmen, follow:

Total Membership

1st—Quebec Chapter, Romeo Martineau
2nd—Oregon Section, Henry G. Lehl
3rd—New Orleans Section, Joseph J. Sanders

Member Grade

1st—Western Michigan Chapter, L. A. Niemeyer
2nd—New Orleans Section, Joseph J. Sanders
3rd—Carolinas Chapter, Edward A. Fargis

Members Emeritus

Eight members of the Society were elected to the grade of Member Emeritus during the past year having retired from regular occupation after having performed for the Society services of such meritorious character as the Council deemed worthy of this honorable award. They are:

William P. Bear	Leonard V. James
George G. Cousins	Clarence L. Law
Frank A. Hansen	Matthew Luckiesh
E. B. Hobbie	Henry Maisonneuve

Fellows

Five members were recommended by the Board of Fellows for election to Fellow grade as having met the Constitutional requirements. After report at the October* and June Council meetings the following were elected by letter ballot of Council.

Willard Allphin
Eugene W. Commery
James M. Ketch
Erwin F. Lowry
Richard G. Slauer*

Deceased

The Society records with sorrow the passing of one Member Emeritus, one Fellow, 10 Members and 27 Associate Members during the year.

Member Emeritus

Alexander D. Cameron

Fellow

George M. Rankin

Figure 1.

TABLE III.—Membership of Sections and Chapters as of September 30, 1950.

	Members Emeritus	Fellows	Members	Associate Members	Student Members	Total
CANADIAN REGION						
Hamilton, Ontario Chapter	0	1	7	33	0	41
Maritime Chapter	0	0	7	26	0	33
Montreal Section	0	0	29	89	3	121
Ottawa Chapter	0	0	9	25	0	34
Quebec Chapter	0	0	8	50	0	58
Toronto Section	1 (1F)	1	41	120	5	168
Winnipeg Chapter	0	0	9	40	0	49
EAST CENTRAL REGION						
Baltimore Chapter	0	0	17	56	1	74
Capital Section	1	3	27	61	1	103
Eastern Pennsylvania Chapter	0	0	48	115	2	165
Philadelphia Section	2 (1F)	2	81	191	1	277
Pittsburgh Section	0	0	52	147	6	205
GREAT LAKES REGION						
Central New York Chapter	1 (1F)	0	18	67	3	89
Cleveland Section	3 (2F)	10	103	225	37	378
Michigan Section	1	1	50	179	0	231
Northwestern Ohio Chapter	0	0	12	27	0	39
Ohio Valley Section	1	0	33	83	54	171
Rochester Chapter	0	0	9	57	0	66
Western Michigan Chapter	1 (1F)	0	20	59	1	81
Western New York Section	0	1	9	63	1	74
MIDWESTERN REGION						
Chicago Section	3 (1F)	3	132	358	57	553
Cornhusker Chapter	0	0	11	63	0	74
Heart of America Section	0	0	27	94	1	122
Indiana Chapter	0	0	18	86	0	104
Iowa Section	0	0	17	76	16	109
Milwaukee Chapter	0	1	21	115	12	149
St. Louis Section	0	0	22	86	1	109
Twin City Section	1	0	26	132	9	168
NORTHEASTERN REGION						
Connecticut Section	2	2	26	97	1	138
New England Section	1	4	76	248	3	332
New York Section	9 (1F)	6	167	345	25	552
PACIFIC NORTHWEST REGION						
British Columbia Section	0	0	15	75	7	97
Inland Empire Chapter	0	0	6	41	0	47
Oregon Section	1	0	21	77	38	137
Puget Sound Section	0	0	19	75	1	95
SOUTHERN REGION						
Carolinas Chapter	0	0	26	67	0	93
Florida Chapter	1	0	21	51	0	73
Georgia Section	0	0	41	98	0	139
Mississippi Chapter	0	0	6	31	33	70
New Orleans Section	0	0	17	66	0	83
Southeast Florida Chapter	0	0	13	37	0	50
Tennessee Valley Chapter	0	0	15	74	3	92
SOUTH PACIFIC COAST REGION						
Mother Lode Chapter	0	0	13	36	0	49
Northern California Section	1	2	49	164	27	243
Southern California Section	2 (1F)	1	71	188	4	266
Utah Chapter	0	0	17	28	0	45
SOUTHWESTERN REGION						
Alamo Chapter	0	2	14	47	1	60
Rocky Mountain Section	0	0	13	74	1	88
San Jacinto Section	0	0	10	63	5	78
Southwestern Section	0	0	33	147	6	186
Foreign Non-Section	1	0	34	157	3	199
TOTAL	31*	40	1,610	5,005	369	7,057

*Includes 9 Fellows of the Society.

Members

Lorin C. Brown	Berthold Monash
J. Carl Fisher	P. C. Neale
H. B. Florkee	Fred A. Rogers
M. S. Glenn	M. M. Samuels
Anthony L. McCabe	Charles E. Scorer

Associate Members

Thomas F. A'Hearn	W. J. Hannigan
W. F. Andrews	Glenn Jeffrey
W. P. Bennie	Lawrence Koch
Louis G. Boomsma	Jules Libby
Charles D. Booker	A. W. Milcke
John L. Brown	George P. Peyla
Peter Diederich	Milton C. Polzin
Henri Duizend	E. O. Schweitzer
George A. Gardner	Paul A. Shrader
Jack G. Gillette	John E. Stephens
Roland C. Graham	John G. Stewart
Leo Guay	William L. Watters
Louis F. Hamilton	Ben R. Womack

Harry F. Young

Local Activities

Local Activities Conferences

Three Conferences on Local Activities were held during the year — April 6, in conjunction with the April Council meeting; May 10 in Montreal, as part of the Canadian Regional Conference; and June 9 in New York, for the annual review of procedures and activities of interest to the local groups. Typical of the discussions at the several Conferences was the program of subjects in Montreal, which included Section and Chapter Boundaries, Regional Conferences, Section and Chapter Organization, National Officers and Committees, Extension Activities, Improvement of Meetings and Programs, Membership Activities, and Public Relations.

Extending the Society's Activities Into New Areas

During the year the following local groups were granted charters:

Western Michigan Chapter, Grand Rapids, Michigan — Charter approved December 8, 1949.

Mississippi Chapter, Jackson, Mississippi — Charter approved April 6, 1950.

The City College Student Branch, New York — Charter approved May 10, 1950.

Northwestern Ohio Chapter, Toledo, Ohio — Charter approved June 8, 1950.

The growth in membership and work in three of the present active Chapters made them eligible for a Section status and by the usual petition the change was made as follows:

New Orleans Chapter to Section — Charter approved October 13, 1949.

South Texas Chapter (now San Jacinto) to Section — Charter approved October 13, 1949.

Rocky Mountain Chapter to Section — Charter approved April 6, 1950.

Regional Conferences

During the past year, seven of the nine Regions held their regular Conference. These were as follows:

February 26-28 — Southwestern — Dallas, Texas

March 6-7 — Southern — Atlanta, Georgia

March 23-24 — Pacific Northwest — Seattle, Washington

May 10-13 — Canadian — Montreal, Que., Canada

May 17-19 — Midwestern — Milwaukee, Wisconsin

May 18-19 — East Central — Philadelphia, Pennsylvania

May 22-23 — Great Lakes — Buffalo, N. Y.

Special effort was made during the year on the advance planning of future Regional Conferences with a view of securing suitable hotel accommodations, together with an integrated schedule to permit the attendance of the President at every Conference.

Meetings of Sections and Chapters for Year Ending September 30, 1950.

	Number of Meetings	Total Attendance	Average Attendance
CANADIAN REGION			
Hamilton, Ontario Chapter	8	339	42
Maritime Chapter	7	174	24
Montreal Section	8	480	60
Ottawa Chapter	9	304	34
Quebec Chapter	11	329	29
Toronto Section	8	739	92
Winnipeg Chapter	6	188	31
EAST CENTRAL REGION			
Baltimore Chapter	9	882	98
Capital Section	7	436	62
Eastern Pennsylvania Chapter	8	1,379	172
Philadelphia Section	8	1,360	157
Pittsburgh Section	7	814	116
GREAT LAKES REGION			
Central New York Chapter	8	415	51
Cleveland Section	6	741	128
Michigan Section	8	983	123
Northwestern Ohio Chapter (Chartered 6/8/50)			
Ohio Valley Section	6	557	92
Rochester Chapter	8	381	47
Western Michigan Chapter (Chartered 12/8/49)	2	106	53
Western New York Section	7	360	51
MIDWESTERN REGION			
Chicago Section	9	1,400	155
Cornhusker Chapter	6	786	131
Heart of America Section	8	949	116
Indiana Chapter	9	410	45
Iowa Section	3	196	65
Milwaukee Chapter	8	557	69
St. Louis Section	10	902	90
Twin City Section	9	671	74
NORTHEASTERN REGION			
Connecticut Section	9	340	37
New England Section	8	762	95
New York Section	8	1,003	125
PACIFIC NORTHWEST REGION			
British Columbia Section	8	324	40
Inland Empire Chapter	7	194	27
Oregon Section	10	472	47
Puget Sound Section	6	213	35
SOUTHERN REGION			
Carolinas Chapter	6	377	62
Florida Chapter	2	58	29
Georgia Section	7	479	68
Mississippi Chapter (Chartered 4/6/50)	2	67	33
New Orleans Section	8	928	116
Southeast Florida Chapter	10	406	40
Tennessee Valley Chapter	6	251	41
SOUTH PACIFIC COAST REGION			
Mother Lode Chapter	9	379	42
Northern California Section	9	525	58
Southern California Section	9	1,035	115
Utah Chapter	7	208	29
SOUTHWESTERN REGION			
Alamo Chapter	9	185	20
Rocky Mountain Section	7	379	54
San Jacinto Section	14	582	41
Southwestern Section	8	406	50
GRAND TOTAL — SECTIONS AND CHAPTERS	372	26,369	70

Representatives to Other Organizations

Relations with other associations and agencies in the fields of science and standardization were maintained during the year through the appointment

Statement of Income and Expense for the Year Ended September 30, 1950

Income

Annual Dues:		
Members	20,261.75	
Associate Members	52,357.35	
Student Members	1,100.00	
Fellows	720.00	
Entrance Fees	2,065.00	76,504.00
Sustaining Members		40,535.00
Sales, Publications, Gross Income		
IES Lighting Handbook	7,500.22	
Lighting Data Sheets, Binders	4,080.98	
Reprints	11,424.35	
ILLUMINATING ENGINEERING	7,173.36	
National Technical Conference Preprints	943.47	31,122.38
ILLUMINATING ENGINEERING, Advertising		56,494.78
Sales, Badges and Certificates, Gross Income		276.41
Interest		
Investments	590.50	
Bank Balances	27.96	618.46
1950 National Technical Conference Income	7,947.00	
Less: Expense	7,479.67	467.33
Total Income		206,018.36

Expense

General		1,206.87
Office, Business	44,135.87	
Office, Technical	21,846.37	
Office, Publications	32,685.79	98,668.03
Organization, Committees	1,656.00	
Regional	138.09	
Sections and Chapters	15,368.06	
President's Travel	2,000.00	19,162.15
Sales, Badges and Certificates, Cost of Stock		213.35
Depreciation—Furniture and Fixtures	500.00	
Publications Stock	502.52	1,002.52
ILLUMINATING ENGINEERING, to members		45,452.60
Sales, Publications, Cost of Stock		
IES Lighting Handbook	2,115.29	
Lighting Data Sheets, Binders	1,226.25	
Reprints	6,706.39	
ILLUMINATING ENGINEERING	4,743.48	
National Technical Conference Preprints	1,322.46	16,113.87
Sales, Publications, Cost of Services, Promotion		6,476.45
Total Expense		188,295.84
NET INCOME		17,722.52

Comparison of Income and Expense for the Past Three Years.

Income

	1947-1948	1948-1949	1949-1950
DUES			
Fellows	615.00	645.00	720.00
Members	15,753.50	17,842.00	20,261.75
Associate Members	46,164.75	48,393.63	52,357.35
Student Members	384.00	740.50	1,100.00
Entrance Fees	2,460.00	2,445.00	2,065.00
Sustaining Members	30,209.37	40,335.00	40,535.00
SALES			
Publications Gross	17,340.36*	30,938.82	31,122.38
I. E. Advertising	———	47,672.24	56,494.78
Badges and Certificates	528.85	520.50	276.41
INTEREST	709.63	666.07	618.46
CONFERENCE, Net Income	1,538.75	109.23	467.33
TOTAL INCOME	115,704.21	190,207.98	206,018.36

Expense

GENERAL	1,502.65	1,090.25	1,206.87
OFFICE	60,832.82		
Business	———	43,181.27	44,135.87
Technical	———	20,925.86	21,846.37
Publications	———	33,174.71	31,685.79
ORGANIZATION			
Committees	2,856.17	1,951.47	1,656.00
Regional	420.82	498.22	138.09
Sections and Chapters	13,622.78	13,746.38	15,368.06
President's Travel	1,500.00	2,000.00	2,000.00
SALES, Badges and Certificates	330.39	324.12	213.35
Depreciation	840.00	745.41	1,002.52
ILLUMINATING ENGINEERING to Members	24,483.99	40,792.63	45,452.60
Sales, Publications, Cost Stock, Services	5,581.87	20,609.93	22,590.32
Miscellaneous	4,003.71**	———	———
TOTAL EXPENSE	115,975.21	179,040.27	188,295.84
NET INCOME	—271.00	11,167.71	17,722.52

*Includes 4,325.45 net income, IES Lighting Handbook 1944 48.
**Expense incident to establishing new Publications Program.

of 17 members to 17 Sectional Committees of the American Standards Association. In addition the Society appointed official representatives to the following:

American Association for the Advancement of Science
Armed Services N.R.C. Vision Committee
Engineers Joint Council, Exploratory Conference
Industry Committee in Connection with the Revision of "Handbook of Interior Wiring Design"
Institute of Traffic Engineers, Joint Committee on Highway Lighting
Inter-Society Color Council
National Committee on Traffic Safety
National Committee on Uniform Traffic Laws and Ordinances
National Engineering Advisory Committee
National Office Management Association, Committee on Physical and Physiological Factors
National Research Council, Division of Engineering and Industrial Research
National Research Council, Highway Research Board
President's Highway Safety Conference
U. S. National Commission of UNESCO
U. S. National Committee of the International Commission on Illumination

Standing Committees

Council Executive

C. H. Goddard, Chairman

The Executive Committee met to conduct the affairs of the Society in the months between Council meetings. A considerable number of operational matters not requiring Council attention were considered, and record of all actions was brought to Council for approval at subsequent Council meetings.

Finance

C. C. Keller, Chairman

Details of the year's financial operation are given in the statement of income and expense included in this report. While the budget, as adopted by the Council for this year, was slightly under the budget for the previous year, and while the income was slightly less than anticipated, the expenditures have been correspondingly less so that we are operating on a planned budget. It should be pointed out that the amount being put to reserves is still less than is desirable and it is the recommendation of the Finance Committee that this amount be increased in the immediate future if at all feasible.

Early in the year the Council

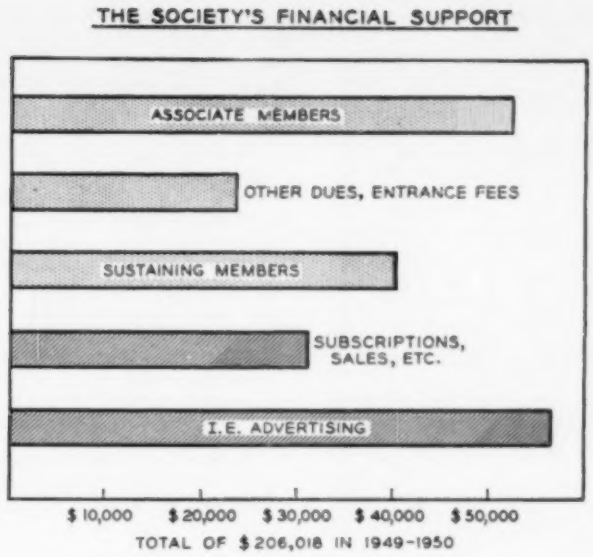


Figure 2.

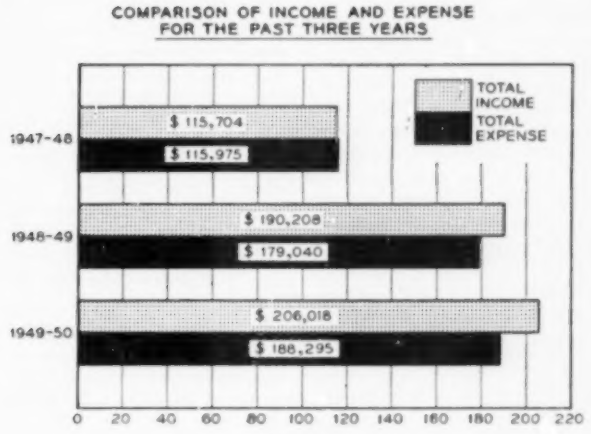


Figure 3.

authorized the Finance Committee to prepare a retirement plan for the employees at headquarters. A workable and practical plan has been prepared and will be submitted with next year's budget to the Council at the first meeting in October.

Board of Fellows

Howard M. Sharp, Chairman

During the year the Board studied each nomination formally submitted to it by the required five Fellows, or Members of the Society. The evaluations by the Board resulted in the recommendation to Council of the transfer of four Members to Fellow grade whose election to this grade was subsequently confirmed by Council's letter ballot.

The Board also studied certain changes in procedure which experience has indicated might be desirable. Those studies will be passed on to the succeeding Board.

General Board of Examiners

E. M. Fahey, Chairman

The General Board of Examiners met monthly throughout the year and carefully reviewed the applications of all desiring election to Member grade.

A new procedure was set up with the Executive Secretary, whereby resignations from the Society also are reviewed, to make sure that anyone who may merit the grade of Member Emeritus is not allowed to leave the Society, without proper recognition. A number of cases involving election to the grade of Member Emeritus were studied carefully and recommendations made to Council, where appropriate.

It is gratifying to report that those concerned in local Sections and Chapters have, in most cases, been prompt and thorough in the processing of applications, thus making possible efficient operation on the part of the General Board of Examiners. However, human nature being what it is, a number of applications are always received in which a casual attitude toward the Member grade is obvious. This is evident from the total lack of documentation on such applications. In such cases, a more complete realization of the value of election to Member grade in the Society is needed on the part of Section and Chapter officers.

Medal Award

G. K. Hardacre, Chairman

The recipient of the 1950 Medal Award is William F. Little.

The Award Committee, operating under the approved procedures, gave consideration to every candidate formally placed before the committee, and at a meeting with all but one member in attendance, took unanimous action on the first ballot which subsequently was supported by the absent member.

A Sub-Committee, under the chairmanship of G. W. Beals, prepared the citation. The medal is scheduled for presentation at the Pasadena Annual Technical Conference.

Papers

Hoyt P. Steele, Chairman

The committee was entirely occupied during the year with the planning of sessions for the Southern California

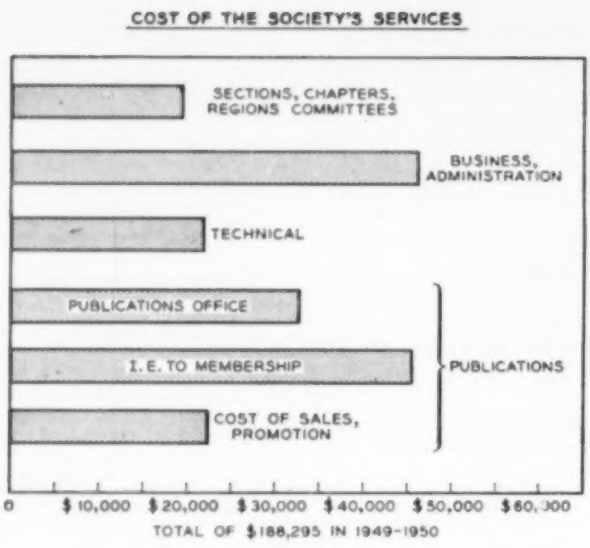


Figure 4.

National Technical Conference at Pasadena, the presentation of an excellent group of technical papers and the organization of the discussion of these presentations. The efforts of the committee were successful in securing the normal preprinting of 27 of the conference papers, which together with seven additional papers privately preprinted, constituted the technical papers program. Preprints and extra manuscript copies of the papers were circulated prior to the Conference for the preparation of discussions, and a discussion organizer was appointed to serve with the chairman of each technical session.

Publications

E. C. Huerkamp, Chairman

ILLUMINATING ENGINEERING — The Administrative year 1949-50 completed the first full year of operation of the Society's expanded publication program which became effective with the January 1949 issue of ILLUMINATING ENGINEERING. This new program was exemplified especially by the development and improvement, including a change in format, of the official publication, ILLUMINATING ENGINEERING. Substantial progress was made by our Society publication during this past year, toward its objective of providing a monthly publication more broadly representative of both the science and art and the practical application of good lighting. Member reaction throughout the country has indicated wide approval of the publication as it has been developing.

Editorial content during 1949-50 continued the policy followed in the past, in which all National Technical Conference papers were published in full, together with discussion, technical committee reports in full, and lighting data sheets. In addition, numerous other articles were published, reflecting the latest applications and techniques of lighting in various respects, (see Table V).

During the year, further policy discussions were carried on, with regard Council's statements in December 1948 and February 1949 concerning the question of full publication of National Technical Conference papers and technical committee reports. The study given this matter during the year indicates that during 1951 some of the Conference papers will be published only in digest form in ILLUMINATING ENGINEERING, some in full with discussion.

Proceedings — On the recommendation of the Papers Committee and the Publications Committee, Council at its meeting in June approved a plan whereby a limited quantity of complete sets of all Conference papers, bound in an appropriate cover would be made available as a "Proceedings" issue, to be sold at a nominal price.

IES Lighting Handbook — In connection with the revision of the Handbook and in preparation for the publication of the second edition, the committee carefully studied a complete budget of probable production and sales expense together with an estimated budget of sales and advertising income. These figures were presented at the April Council meeting and subsequently were considered by both Council Executive Committee and the Finance Committee.

Advertising and Promotion — The

G. D. Mills, Co-Chairmen

Advertising and Promotion section of the Publications Office has been set up for:

The sale of advertising in ILLUMINATING ENGINEERING and other publications

The sale and distribution of all Society publications

Instituting the procedures and office routine appropriate to sales promotion

The Advertising and Promotion Manager is assisted by his secretary and by nearly full-time help of one clerical assistant in the Headquarters office.

He is responsible for the sale, billing and collections of advertising space in Society publications; the prepara-

TABLE V—Illuminating Engineering Page Content by Subject Matter

	Jan. to Sept. 1949	Oct. 1949 to Sept. 1950
Technical Conference Papers	215	176
Technical Committee Reports	91	144
Other Papers, Articles and Reports	88	216
Lighting Data Sheets	29	33
Editorials	4	3
Telecast including Current News, Society Affairs, Letters to the Editor	122	119
List of Officers, Committees, Sustaining Members	37	42
Advertising	226	256
Total Pages Published	812	991

tion and mailing of promotional literature, make-up of the advertising section, records of circulation; the development of market data, reader information of interest to advertisers, and correspondence dealing with advertising. The appropriate number of personal contacts on a national basis with advertisers and prospects and their advertising agencies, is another responsibility. Thus, it may be seen that a very close rationing of office work and outside travel is required.

Nearly 100 manufacturers of lighting equipment, materials and supplies for the lighting specialist have used or are using our publication regularly to carry their advertising messages. Regular advertisers are most enthusiastic about ILLUMINATING ENGINEERING as an advertising medium. The revenue derived from advertising has helped contribute to an expanded publication service.

The promotion of the sale of other I.E.S. publications, such as the Lighting Handbook; Recommended Practices, and committee reports on lighting in various industries is the task of the Advertising and Promotion Manager. These are sold through the Publications Office, individually or in quantity. Every effort is made to insure prompt and accurate compliance with purchase orders and to charge reasonable prices which are consistent with printing, mailing and handling costs. Office routine surrounding this sales function with maintenance of accurate inventory and sales records is a sizeable operation.

Sales promotion of individual copies is developed through advertising space in ILLUMINATING ENGINEERING; by timed notices to other lighting publications; direct mail, and through notices to Sections and Chapters. These efforts have resulted in the dissemination of the technical output of the Society throughout the lighting field, as well as lesser fields of activity.

During the past ten months, exclusive of subscribers to ILLUMINATING ENGINEERING, and to the Lighting Data Sheet series, a total of 27,255 copies of I.E.S. publications have been distributed through the Publications Office, an average of over 2,725 per month. In addition, there are at present 1,446 subscriptions to the current Lighting Data Sheet series.

General Committees

Board of Nomination

G. K. Hardacre, Chairman

Operating under procedures specified in the Constitution and By-Laws the appointment of the Board was initiated at the October Council meeting by the selection of the three past-presidents and the chairman of the Board. The appointment of the representatives by the respective Sections was accomplished and the Board held its meeting for the slate of national officers in February. Extensive records of active members and previous officers of the Society were prepared and circulated to the whole Board for their study in connection with the selection of the slate.

Constitution and By-Laws

R. W. Corwin, Chairman

The committee received no matters for official consideration during the fiscal year.

Defense Coordinating

A. F. Wakefield

G. D. Mills Co-Chairmen

Continuing the policy adopted by this committee last year, the lighting requirements for that part of the Government which had to do with the peacetime functions of Government were completely ignored, since the committee is concerned only with lighting problems connected with National Defense.

Task Committee No. 2 for National Defense has been organized under the Chairmanship of L. M. N. Bach of Tulane University. Although this committee work is classified, it can be stated that all branches of Defense Services fought the clock-around except the infantry. Experiments of "Artificial Moonlight" are being investigated.

It is believed the existence of this Committee has encouraged further joint meetings between the Society of Military Affairs and the Illuminating Engineering Society at Section and Chapter levels.

Mention should be made of "The Bibliography of Blackout and Dimout Practices during World War II" as a valuable adjunct of this committee program.

Historical

S. G. Hibben, Chairman

The committee completed a survey of the Society's first ten years of history which was circulated to the committee members for review. Statements were prepared for the four earliest Past-Presidents of the Society for permanent recording by phonograph.

Lighting Service

J. S. Walsh, Chairman

The committee began its work with a review of the three previous Lighting Service Forums, and a decision was reached upon a general theme and type of presentation for the 1950 Conference. The program for current Forum was discussed as it developed, and suggestions offered were included in the script. A meeting of the committee was held at the Conference to evaluate the success of the Forum and to offer recommendations for future committee chairmen.

Local Activities

S. G. Hibben, Chairman

The work of this committee is outlined in the preliminary pages of this report.

Membership

Garlan Morse, Chairman

The work of this committee is outlined in the preliminary pages of this report.

National Technical Conference

R. F. Hartenstein, Chairman

The final report of the French Lick Conference was presented by the chairman at the December meeting of Council. The report revealed (1) That the Conference was self-supporting, in fact there was a surplus after all bills were paid; (2) Many favorable comments were received regarding the success of the Conference; (3) That all the committees were to be complimented on a job well done.

The National Technical Conference

Conference Attendance During Last Ten Years.

		Total
1941	Atlanta, Georgia	573
1942	St. Louis, Missouri (2-Day)	516
1943	New York, New York (1-Day)	126
1944	Chicago, Illinois	721
1945	No Convention	....
1946	Quebec, Quebec	807
1947	New Orleans, Louisiana	695
1948	Boston, Massachusetts	906
1949	French Lick, Indiana	668
1950	Pasadena, California	556

Committee is working with the Conference Executive Committee, the Papers and Publications Committee in planning the 1950 Conference in Pasadena, California.

At the request of Council, the Chairman of the National Technical Conference Committee obtained the written agreement of each Regional Vice-President to hold the 1952 Conference in Chicago, and the 1953 Conference in New York City. Then Council, at its April meeting, approved the recommendations of the Chicago Section and the National Technical Conference Committee to hold the 1952 Conference at the Edgewater Beach Hotel, Chicago, Illinois, September 8 to 13.

Council also approved the recommendations of the New York Section and the National Technical Conference Committee to hold the 1953 Conference in New York City.

The Committee had hoped to revise the Manual of Convention Procedure but was unable to do so due to the fact that the Procedures and Policies Committee of the Society had not approved the National Technical Conference Committee's suggested revision of the Conference Policies and Procedure presented to them some time ago.

Procedures and Policies

R. W. Staud, Chairman

The committee has under active consideration a number of matters referred to it by the Council of the Society including:

A re-definition of the Society's Policy on the Preparation of Illumination Performance Recommendations for Luminaires.

A policy regarding re-consideration of the previous recommendations regarding the designation of Member Emeritus and the possible substitution of a new classification of Life Member or Fellow for Life.

A proposed statement of Policies and Procedures for National Technical Conferences.

A suggested policy to be used as a guide by the Board of Nomination in selecting Directors for the Society.

Professional Requisites

R. L. Biesele, Jr., Chairman

This committe has four reports in preparation.

Project Planning

J. F. Whitehead, Jr., Chairman

A number of projects were given informal consideration by the committee during the year but did not result in any formal recommendations to Council.

Public Relations and Information

J. S. Schuchert, Chairman

Broad public relations and information objectives might be accomplished by the expenditure of large sums of money for the services of an outside public relations and publicity agency, for expensive promotional programs, for brochures, films, or for other promotional aids, but the budget of the Society will not permit elaborate programs at this time. Thus, the committee confined their discussions and studies to the development of a program which can be conducted largely within the framework of the present staff personnel and volunteer committee membership.

The committee decided that a great deal could be accomplished if all of the volunteer and staff personnel cooperated by adopting certain basic suggestions and making them actually "happen." This led to the development of a report which outlines an overall objective public relations and information program which may require only a small budget but will necessitate the active participation of certain staff and volunteer personnel, as well as a number of the committees of the Society. The report has been approved by Council and the committee responsible for the preparation of the recommendations strongly urges that every effort be made to activate the program during the coming year.

All of the things that have been done, are being done or are contemplated by headquarters or by committees which might be considered valuable from the standpoint of public relations and information have been listed. They have been classified and organized as internal or external effort. They have been supplemented by the various ideas of the committee and the outline report referred to covers an overall objective public relations and information program.

In addition to preparing this report, the following three items were completed during the past year:

1. Every effort was made to have each Section and Chapter appoint a local Committee on Public Relations and Information.
2. The "Guide for Sections and Chapters to Follow in Building Public Relations in Their Community" was revised and released to all Sections and Chapters with a suitable forwarding letter and announcement covering the use of the guide.
3. Suggestions were prepared covering advertising to be done by the Society in its own magazine and to be used as reprints for mailing.

The committee hopes that the work which has been done during the past year, plus the recommendations made which should be activated during the coming year, will help "sell" the Society to its members, to its Sustaining Members and to the public at large in a measure more comparable with the outstanding services being rendered.

Research Fund

Lee E. Tayler, Chairman

The committee developed numerous approaches to various parts of the lighting industry, some of which have resulted in substantial contributions to the I.E.S. Research Fund.

Residence Lighting Forums

Priscilla Presbrey, Chairman

Three Residence Lighting Forums—New York, Michigan and Atlanta—have been active throughout the year. The Atlanta Forum, under the able chairmanship of Miss Ruth Morris, has made unusually good progress in its first full year of operation. The total of 17 meetings held by the three organizations included a wide variety of interesting and stimulating programs. In addition to its regular meetings the New York Forum, in cooperation with the Division of General Education of New York University, presented an eight-session course on "Practical Methods of Lighting Residential Interiors." Although the course had only 22 registrants, the University has expressed the desire to repeat it next year under the same arrangement, by which the course is listed as one of the regular offerings of the University, but the Forum is entirely responsible for planning the program and providing the speakers.

The possibility of organizing new Residence Lighting Forums is under tentative discussion in two or three locations, but the committee knows of

no situation that is likely to crystallize into action this year. There seems to be an increasing general interest in residence lighting as a subject for Section and Chapter meetings and Regional Conference programs, which is an auspicious omen. However, the actual Forum movement is still slow to get under way, and in many areas awaits greater activity in the home lighting field.

Because of the location of the 1950 National Technical Conference it seemed not practicable to try to prepare a Residence Lighting Forum session for the Conference Program this year. However, the committee has requested, and been granted, 15 minutes of the technical residence lighting session for a discussion of Forums, so that the Forum story can be presented to our members on the West Coast.

Section and Chapter Programs, Coordinating

Carl A. Basedow, Chairman

Copies of the committee's 1947-48 report "Planning and Conducting I.E.S. Section and Chapter Programs" were made available through headquarters to all local groups.

Sustaining Membership

George J. Taylor, Chairman

The committee concentrated efforts during the year on its prime objective of electing and maintaining Sustaining Members. The addition of new members was offset somewhat by members discontinuing their support due to removal from the lighting field. In several instances a numerical decrease occurred due to the merger of companies. Taking all gains and losses into account the year ended with a net increase of one member.

The general operation of the committee was as follows:

The appointment of the three-man committee in each of the Sections and Chapters.

Appointment of a national committee including nine regional representatives and the nine Regional Vice-Presidents.

Circulation of copies of the new brochure and of the Procedures and Policies for Election and Maintenance of Sustaining Members to all of the committees.

Solicitation of lists of good prospects from the Sections and Chapters.

Considerable correspondence with the individual Sections and Chapters concerning the prospects and the suggestion of prospects.

Mailing of a direct mail letter together with a copy of the I.E.S. Brochure to a sizable number of prospects.

Other activities in conjunction with the work of the Sustaining Membership Committee were as follows:

Mailing of letters by the Executive Secretary each month together with the dues invoices to Sustaining Members being billed.

Follow-up each month to Sustaining Members and to Sustaining Membership Committee representatives concerning delinquent Sustaining Membership dues payments.

Correspondence concerning resignations which have been submitted or delinquent members to be dropped under the constitutional provisions.

General Secretary's letter in January to all Sustaining Members reviewing the previous fiscal year and accompanying the mailing of the I.E.S. Brochure.

One or two mailings from the Publications Office to all the Sustaining Members announcing new publications.

Solicitation of the Sustaining Members for suggestions for the Section and Chapter Speakers List.

Number of Sustaining Members and Dues Income for Past Six Years.

	Number of Members	Dues Income
1945	237	$20,031.00
1946	265	21,881.00
1947	314	28,705.63
1948	326	30,209.37
1949	315	40,335.00
1950	316	40,235.00

Task Committees

Joint I.E.S.-A.P.H.A.

E. M. Strong, Chairman

One meeting of the committee was held during the year providing a thorough discussion of the fundamental problems underlying the recommendation of illumination levels. Recommendations are in the course of preparation for referral to the appropriate Society committees.

Increase in Membership Dues

E. M. Strong, Chairman

The committee submitted recommendations to the Council at its February meeting pointing out the needs for increased Society income, and proposing increase in Associate Member and Member dues. The proposal was put to letter ballot of Council but did not reach a decision, the matter being tabled for future consideration.

Conference with National Council for Schoolhouse Construction

R. C. Putnam, Chairman

During the year the committee continued to maintain contact with the members of the National Council for Schoolhouse Construction.

Fiscal Year

Berlon C. Cooper, Chairman

The committee's study of its assignment resulted in one progress report to Council at its June meeting, and an invitation to Council Members and interested Committee Chairmen requesting discussion and comment. The thinking of the committee is summarized in the following:

It is the consensus of the committee that the proposed new fiscal year, starting July 1st, has both advantages and disadvantages but that possible advantages are sufficiently important to justify a thorough study. The committee thinks it important to realize that large constitutional changes would be involved which make it impractical to place a new fiscal year proposal before the membership in the 1950 ballot. The committee does not feel in the position to make a recommendation to Council without a thorough, but not necessarily long drawn-out study of the impact of a new schedule upon such items as the following: Conference Date; Committee Appointments; Membership Dues; Financial Year; Date of National Elections; Date of Local Elections; Schedule of Technical Committees; Regional Conference Dates; Papers for National Conferences; Constitutional Changes; Operations of Membership and Sustaining Membership Committee; Date of Last Council Meeting of Old Administration; Date of First Council Meeting of New Administration.

Technical Committees

Aviation Lighting

Lewis B. Moore, Chairman

A two-day conference was held at the Civil Aeronautics Administration Technical Development Center at Indianapolis, Indiana in October with 34 members and guests in attendance.

Papers covering various phases of aviation lighting were presented and discussed and the committee inspected latest type slope line approach lighting installations. The regular spring meeting was not held since all committee efforts were directed toward preparation for the Aviation Lighting Session at the National Technical Conference.

The status of the work of the various sub-committees, which are a part of the main Committee, is as follows:

Sub-Committee on Aviation Lamps

V. J. Roper, Chairman

The list of "Lamps for Aircraft, Aerodrome and Airway Lighting, I.E.S.-S.A.E. Recommended Practice of Lamps for Aviation" was approved by both interested societies and was published in ILLUMINATION ENGINEERING of April 1950. This list will also be included in the revised Handbook. The committee will remain active to revise the list as new lamps are standardized for aviation use.

Sub-Committee on Compendium

F. C. Breckenridge, Chairman

Progress has been made by this Committee during the year and authors and reviewers are working on the various chapters. It is anticipated that Part I will be ready for release before the end of the year. It was decided that the material would be issued in chapters so that the much needed information might be available to aviation engineers as soon as possible.

Sub-Committee on Airport Lighting

L. C. Vipond, Chairman

It was planned to promulgate a "Recommended Practice for the Lighting of Small Airports" separate from the recommended practices as set forth in Section 13-43 of the Handbook and entitled "Field Lighting for Airports." Since standards for the lighting of small airports have not been accorded acceptance by all aviation interests it was deemed desirable to postpone the preparation of this material. The committee will remain active and will give further attention to the smaller airport problem as soon as the differences of opinion can be reconciled.

Sub-Committee on Approach and Runway Lighting

Little progress can be reported for this Committee due to the fact that there is considerable controversy relative to approach lighting. The previous chairman resigned because it was his feeling that military and other government agencies were the only ones in a position to do original work on the subject. A special task committee has been appointed to review the achievements and limiting conditions of the sub-committee's work and to recommend what future assignments if any should be made. It is intended that this task committee should report in the near future so that further consideration may be given to the problem.

Sub-Committee on Aircraft Lighting

R. A. Rugge, Chairman

Progress is being made on the guide report for aircraft lighting but no definite date can yet be established for the completion of this work. Some delay was incurred when the chairman changed his business affiliation but the work has since been further subdivided to facilitate the task of compiling this voluminous information. A draft of some 50 pages submitted in January is now being revised and expanded in scope. It is hoped that a good portion of this report will be ready this year.

Sub-Committee on Taxiway Lighting

M. A. Warskow, Chairman

This committee has continued work on the improvement of taxiway lighting and the development of suitable route markers. The group has had several meetings and has inspected new taxiway lighting installations. Requirements for good lighting have been outlined. Study is under way on the functional distribution for taxiway lights and the results of the Landing Aids Experiment Station Arcata tests will be coordinated with such studies.

Sub-Committee on Definitions and Terms

J. F. Angier, Chairman

The recommendations of this committee hinge upon those of the International Civil Aviation Organization. Final decision on definitions and terms has been deferred for some considerable time. Until ICAO's work is completed this committee can take no further action. It is hoped that a decision will be reached some time during the coming year.

Sub-Committee on Lighting Study Projects

F. C. Ashe, Chairman

This committee has been re-organized with a new chairman and is reviewing special subjects which appear to merit study. A task committee is studying C.A.A. safety reports on air accidents to determine where such accidents can be attributed to faulty or misleading visual signals. A report will be presented at the next meeting. Projects involving hangars and apron lighting, helioport lighting and control tower lighting have all been studied with the purpose of drawing up a recommended practice.

Sub-Committee on Papers

R. E. Madigan, Chairman

An excellent paper on the "Effect of Source Size Upon Approach Light Performance" by G. M. Kevern was published in ILLUMINATING ENGINEERING of February. Several very fine papers were presented at the October meeting including a comprehensive treatment "Recent Developments in Visual Low-Approach and Landing Aids for Aircraft" by Dr. Maurice A. Garbell. Papers covering the various major divisions of aviation lighting will be presented at the National Technical Conference.

Assignments have been made pertaining to the revision of material for the IES Lighting Handbook. Several of the sections will be expanded to more adequately cover the subjects.

It is felt that considerable progress has been made on the various projects undertaken by the committee. The Compendium on Signal Lighting and the Guide Report on Aircraft Lighting involve the joint efforts of the committee members and some 30 or more authors. The task of accumulating and reviewing the required material is of major proportions and must necessarily move slowly. It is hoped, however, that a good portion of the work may be brought to a satisfactory conclusion this year.

Color and Illumination

Ralph M. Evans, Chairman

There have been two meetings of the committee during the year, one on February 10 and one on March 9, both in New York City. It was decided at these meetings that since revision of the chapter on color for the IES Light-

ing Handbook was urgent and rather badly needed that no other work would be attempted by the committee in the current year. To accomplish this the entire chapter was circulated to each member of the committee requesting detailed comments. Some 15 out of the 23 members of the committee complied with this request, and the chairman is now in process of re-organizing the chapter along the lines suggested. Because of the magnitude of the operation, it is not expected that a fully revised chapter will be ready in time for the new edition, but it is the feeling of the committee that several successive revisions will be necessary before they are wholly satisfied with its content.

At the recommendations of a number of members of the committee a sub-committee report by the present chairman on the "Psychological Aspects of Color and Illumination" was submitted to the Publications Committee for publication.

Daylighting

R. L. Biesele, Jr., Chairman

The work of this committee has been confined largely to revision of the Daylighting Section of the IES Lighting Handbook. The committee has also reviewed and made recommendations for revisions of the Daylighting sections of several reports in preparation by other technical committees of the Society.

Farm Buildings and Work Area Lighting

O. D. Hunt, Chairman

The committee continued its work by correspondence during the year on the proposed Recommended Practice of Lighting for Farmsteads.

Handbook Revision

Bruce J. Jensen, Chairman

The revision of the IES Lighting Handbook was initiated by action of Council when it accepted, in April 1949, the Publications Committee recommendation that publication of the second edition of the Handbook be scheduled in September 1951. Following the appointment of the Handbook Revision Committee in October 1949, a plan of operation was prepared which the Council Executive Committee approved in November 1949. Vice-President Sturrock alerted the technical committees in November 1949 that the Handbook Revision Committee would be requesting them to prepare material for the new edition, and the committee in November 1949 made assignments for revision, requesting completed manuscripts by May 1, 1950. The committee prepared and submitted a budget for Handbook processing and publication to the Chairman of the Publications Committee in February.

During 1949-50 approximately 30 technical committee meetings were held specifically for Handbook revision not including a considerable number of meetings of special task subcommittees formed for Handbook revision purposes. About 25 individual authors and two outside organizations are preparing sections not covered by Society committees. The Technical Director's office, working closely with the Handbook Revision Committee, has received manuscripts representing approximately 50 per cent of the total Handbook pages.

Illumination Performance Recommendations

J. F. Parsons, Chairman

The committee continued work on the development of a classification system for luminaires based on the photometric characteristics of flux and brightness distribution. New, recently published basic laboratory data on the relationship between discomfort and brightness distribution in the field of view was studied by the committee and some progress made in developing a practical application of these findings to the classification system for luminaires. Further work along this line is now in progress.

Industrial Lighting

W. C. Brown, Chairman

The committee has contacted the Committees on Supplementary Lighting, Daylighting, and Wiring (Industry Wiring Committee) for abstracts which can be incorporated in the revision of the American Recommended Practice of Industrial Lighting. These abstracts will be submitted to the members for approval as soon as received.

The revised table of specific recommended values of illumination for various tasks has been completed and sent out to the committee members for approval. Suggestions from committee members on the second draft of the text of the recommended practice are being incorporated in a new draft.

Light Control and Equipment Design

F. C. Winkler, Chairman

The Committee on Light Control and Equipment Design has directed most of its efforts toward the re-writing of Section 7 of the IES Lighting Handbook, which will be entitled "Light Control and Equipment Design."

Another function of the Committee is the revision of Sections 30 and 30.2 of the Society's publication "Illuminating Engineering Nomenclature and Photometric Standards." Copies of the present standard together with several proposed changes have been circulated to the Committee for study.

Light Sources

Erwin F. Lowry, Chairman

The Committee has held three meetings during the year; each of these meetings consisted of a two-day session.

The work of the Committee during the year has been devoted entirely to our assignment in re-writing Sections 1 and 6 of the IES Lighting Handbook. Section 6 required quite a little revision and the incorporation of a large amount of additional material. This revision has been essentially completed. There has been some delay in the work on the revision of Section 1 but this is now finished.

Lighting and Air Conditioning

E. H. Salter, Chairman

This Committee held its organization meeting in January and laid out for itself the following program of activities:

To set up cooperative arrangements between the Society and American Society of Heating and Ventilating Engineers for correlating available data on the effects of lighting on air conditioning and of air conditioning on lighting with the idea of presenting these data to the two societies through their publications; and to plan and suggest the initiation of investigations by both groups to fill in data where it is recognized as being not available at this time.

It was further decided to examine the field as a whole in this approach rather than to make a random attack on certain problems that may have

been brought to the attention of either society.

The Committee accepted as an immediate assignment the preparation of material for the revised IES Lighting Handbook.

In starting work on the above program, the Committee is investigating the availability of data on the following subjects:

1. Heat characteristics of the commonly used lamps. (In particular spot and flood lamps and fluorescent lamps).
2. Light and heat transmission characteristics of various glasses and other materials finding use in windows.
3. Space distribution of radiant energy from lighting fixtures.
4. Effects of panel heating installations on heat dissipation from fixtures.
5. Room comfort conditions as affected by radiant energy.
6. The effect of air conditioning systems on light sources.
7. Preparation of a bibliography of source material on lighting and air conditioning.

Lighting and Architecture

H. E. D'Andrade, Chairman

The committee's assignments for the year were three-fold:

To review and re-edit Section 10 of The IES Lighting Handbook for the new edition of the Handbook now under consideration.

To develop a Lighting Manual for architects.

To foster an Architectural Competition for Sections and Chapters.

The Committee has completed the revision of the architectural lighting section (No. 10) of the Handbook. This work has involved re-writing a large part of the text, and condensing information in a short form through summaries and tables.

Owing to the work of Handbook revision, the Lighting Manual for architects has not been developed. However, the revision of the text on Interior Lighting, Section 10, should provide a good basis for the architectural manual. A different approach is necessary for architects, but much basic information is now in written form because of the work on the Handbook.

The Architectural Competition for Sections and Chapters awakened interest in a few Sections, and local competitions were fostered in a few universities. It is the conviction of the Committee, however, that until the Society is able to finance a National Prize Award, an architectural competition on a local basis will depend primarily on Section enthusiasm and support.

Lighting of Central Station Properties

Arthur A. Brainerd, Chairman

Two two-day meetings, and one one-day meeting have been held during the year.

A final draft of the report, Lighting of Control Rooms, has been completed and sent to members of Council for study. Preliminary reports have been prepared on:

1. Lighting of Load Dispatch Rooms and Telephone Switchboard Rooms
2. Lighting of High Bay Areas
3. Lighting of Outdoor Locations

With much basic work completed, it is anticipated that the coming year should see a substantial progress towards completion of the recommendations for the lighting of generating stations and substations.

Lighting Design Practice

Charles L. Amick, Chairman

The Committee revised and presented to Council on February 8 a report covering uniform methods for computing and presenting Room Indexes, Coefficients of Utilization and Maintenance Factors. This report was accepted by Council and referred to the Publications Committee. The standards set by this report have been used by the Committee in preparing the revision of Section 8 of the IES Lighting Handbook. In addition to the latter project, the Committee continues the general study of lighting calculations, with a view to improving their accuracy and usefulness.

Lighting Education

C. D. Miller, Chairman

Following a recomendation of last year's committee, available I.E.S. publications were listed in several issues of ILLUMINATING ENGINEERING this past year. Through this means of publicity, all the excellent reference data and "Lighting Courses" developed by committees of the Society were brought to the attention of the entire membership. Increased interest in this reference material and its use is indicated by the number of orders received at headquarters. The demand for the "Lighting Courses" was particularly gratifying, as there were 635 ordered during the year.

Tentative outlines for an "Advanced Lighting Course" were considered but further study as to the form and subject matter is recommended.

A survey as to the availability of illumination courses in colleges and universities was started and will continue until a complete record is obtained.

The joint Sub-Committee, I.E.S. and U. S. Public Health Service has prepared the first draft of a pamphlet on "How to Make a Lighting Survey" and the several chapters have been distributed to members of the Sub-Committee for review and suggested revisions. Following coordination of this material, the full Sub-Committee and representatives of the Sub-Committee on "Pictorial Representation" will meet to reach full agreement on the text of the pamphlet and discuss the extent and nature of the illustrations which will be prepared by the U. S. Public Health Service. Last year's Sub-Committee on "Pictorial Representation" submitted two possible approaches to the pictorial definition of illumination terms and these will be the basis for discussion at the forthcoming meeting of the two Sub-Committees.

Several Sections and Chapters have reported excellent attendance at illumination courses sponsored by the local I.E.S. Education Committees. Also reported are numerous lectures by I.E.S. members to Architectural and Engineering students, all of which have been well received. In many instances requests were made to repeat these lectures before next year's classes. This growing interest in illumination and the desire for more information expressed by those outside our membership is a challenge to the Society that cannot be ignored. Sections and Chapters should take advantage of every opportunity to educate the uninformed on the subject of illumination.

Lighting Maintenance

D. C. Freeman, Chairman

In the first year since its establishment this new committee has been laying the ground work for the preparation of a guide for conducting maintenance studies. It is expected these

studies will be carried on under the jurisdiction of the application committees in different parts of the country under a range of atmospheric conditions and using various luminaires.

Lighting Study Projects in Educational Institutions

R. C. Putnam, Chairman

The committee continued its review of seeing and lighting problems in educational institutions in the selected fields for study projects, including Brightness Conditions in Educational Environments, Chalkboards, Student Vision and Scholarship and Visual Problems.

Lighting Study Projects in Industry

E. W. Fowler, Chairman

This committee accomplishes its assignments chiefly by correspondence. One meeting, however, was held during the fiscal year with only two of its members absent. The general problems of the assignment were discussed and plans laid for expanding subcommittee work such as the Rubber, Paper and Pulp, Mining, Synthetic Fabric, Cotton Processing Industries. Negotiations are under way for forming these sub-committees.

Instructions and guides for Industry Committee studies and reports as developed under past-chairman Marshall N. Waterman continue to form the basis of approach in attacking the lighting problems and formulating the reports.

The following reports have been accepted by the Illuminating Engineering Society during the fiscal year:

Lighting for Bakeries

Lighting for Canneries

The Handbook Revision Committee requested this committee to work on revision of Section 10-104 to 10-137. A sub-committee was established under the chairmanship of M. N. Waterman and with the cooperation of the various Study Project chairmen has made excellent progress.

Status of individual study projects is as follows:

Cleaning and Dyeing — A newly activated committee promises to get under way with an aggressive approach to the problem.

Fluid Milk — Inactive.

Foundries — Seven meetings have been held with one more scheduled in 1950. A preliminary draft has been reviewed by the General Committee and returned to this committee with suggestions. A revised report is expected to be available for approval by the General Committee in the Fall of 1950.

Laundries—Two meetings were held. Test installations in a commercial laundry have been completed. Final work is being done at the American Institute of Laundry and Cleaning. The research report is expected to be given to General Committee in the latter part of 1950 for review.

Leather — Preliminary work has been done and received by the General Committee. Completion of work held up because plant under study closed. Efforts are being made to form a new committee to complete the study.

Printing — Three committee meetings have been held to date. Some field work has been done at Government Printing Office on proof room lighting. Lighting for linotype area is being considered for trial installation. Proof room lighting report may be available by the end of 1950.

Sheet Metal — Two meetings were held to prepare a revision for the Handbook which was submitted on April 26, 1950. Photographs have been made and brightness readings taken covering shear operation. The committee expects to complete its study in the Fall of 1950.

Steel Mills—Part I—Open Hearth—Report was approved by General Committee—submitted to Council for action on final acceptance.

Supplementary Lighting — A great deal of study has been given this broad subject. The second draft has been completed and distributed to the subcommittee membership. Report is promised for submission to the General Committee prior to the end of 1950.

Textile Industry — No report of progress.

Woodworking—New committee has been formed. Plans to have initial draft during 1950-51 fiscal year.

It is hoped that work now under way will be expedited to completion and that the Society will be able to find the manpower to expand new assignments. Many gaps of important industrial lighting applications are apparent. Solutions to these should be exceedingly valuable to the Nation in peace or war. The Lighting Study Projects in Industry Committee would appreciate the active interest of all the Society's membership in being alert to opportunities for industry study of lighting problems not already covered. In various areas of the country there appear particular concentrations of types of production such as textiles, rubber, woodworking, paper and pulp, etc. The committee would appreciate any suggestions and offers of cooperation which can be made.

Lighting Study Projects in Public Buildings and Private Institutions

Robert S. Rogge, Chairman

No study project reports resulted from this committee's work but definite progress was made in the form of re-organizing the specific duties of the four sub-committees which carry out the actual investigations. The re-organization included a clarification of the intent of Lighting Study Projects Reports as compared to Recommended Practices and a breakdown of the specific assignments of the sub-committees.

Following is a tentative list of the various assignments to be carried out by the sub-committees. The intent is to have a report submitted as each assignment is completed rather than hold up material awaiting completion of all assignments.

Lighting in Hotels: guest rooms, dining room, kitchen, lobby, ballroom, lounge, meeting rooms, corridors, writing rooms, emergency lighting.

Lighting in Auditoriums and Churches: auditoriums, Sunday school rooms, pulpit or altar, apse, chancel, transept, nave, aisle, choir, niche, emergency lighting.

Lighting in Hospitals: operating rooms, laboratories, private rooms and wards, mental wards, waiting rooms and lobby, solarium, kitchen, laundry, color conditioning, corridors, emergency lighting.

Lighting in Theatres: lobby or foyer, auditorium, stage, movie screen, dressing room, aisles, ticket booth, hall and stairways, emergency lighting.

Nomenclature and Photometric Standards

Harris Reinhardt, Chairman

The activities of the committee during the past year were directed towards two major projects. The first was an effort to work out an acceptable compromise between present

nomenclature for photometric and radiometric terms and the changes suggested by the Optical Society of America as more suitable to their needs in certain areas. The American Standards Association looks to the Illuminating Engineering Society as proprietary sponsor of nomenclature in these fields and, therefore, the Society has a responsibility to work with other groups who make extensive use of radiometric and photometric terms. Encouraging progress has been made and a compromise which, it is believed, will adequately meet the needs of both groups has been approved by the Nomenclature Committee.

The second project is the expansion of the official nomenclature to include definitions for more of the terms used in the working vocabulary of illuminating engineers. This project is being carried out in cooperation with other Society Committees covering the various fields involved. Most of these committees have been obliged to give priority to their work on the revision of the IES Lighting Handbook, but it is believed that a start in the right direction has been made and that results will be forthcoming.

Office Lighting

George P. Wakefield

The committee under the leadership of John Neidhart as Chairman of the Handbook Revision Committee has been working continuously on the Handbook revision of the Office Lighting Section. At present the third draft has been completed and will shortly go to committee for action.

The committe has gone on record as accepting reflectances of 30-35 per cent plus or minus five per cent for office furniture, machines and equipment.

In order to void the divergencies between the American Standard Practice of School Lighting and the Recommended Practice of Office Lighting, the committee unanimously recommended the discontinuance of further action in having the Recommended Practice approved by the American Standards Association.

In cooperation with the Committee on Illumination Performance Recommendations, a general plan of brightness and zone specifications has been decided on which presumably will offer future data for recognition by the A.S.A. The chairman feels that more factual data are necessary in the reflected glare zones to further clarify these brightness limitations before attempting a new Office Recommendation.

Protective Lighting

J. W. Lee, Chairman

A meeting was held at headquarters on June 27th, and assignments were given to each member of the committee for revision of a section of the IES Lighting Handbook. These revisions will be reviewed by the various members of the committee, and the complete report submitted to the Handbook Revision Committee.

Progress

Alston Rodgers, Chairman

The committee maintained contact with the art of lighting throughout the world and prepared a yearly review of the achievements in the Art of Lighting for publication in ILLUMINATING ENGINEERING. This review was given a dramatic presentation as one of the features of the 1950 Southern California National Technical Conference, at Pasadena.

Public Conveyances, Interior Lighting

E. W. Beggs, Chairman

A two-day meeting of the committee was held on March 28 and 29. The first objective was to complete a study on the application of fluorescent lamps to railway cars, buses, etc. That was done and it has been written up in a preliminary report. The second objective was to revise the section of the IES Lighting Handbook. Two drafts have been made — the second is now being reviewed.

Research

H. L. Logan, Chairman

The Committee's interpretation of the directive governing its activities is as follows:

1. To survey and report on current research dealing directly or indirectly with:
   (a) application of light
   (b) application of lighting
   (c) effect of light and lighting upon behavior, comfort, health and safety of human beings.
2. To coordinate various researches affecting light and lighting currently being conducted by various agencies.
3. To survey the whole field of lighting to determine and report on subjects which require scientific verification and development through research.

Machinery has been set up to deal with items 1 and 2, with the cooperation of the headquarters' staff. The present status of this activity is that 123 leading educational organizations were approached for information on their current research in the light and lighting fields; 90 replied, and a bulletin was prepared showing the nature of the research and the department conducting it, etc.; which bulletin has been mailed to all of the institutions originally approached, so that all are now generally aware of what research has been reported in the light and lighting fields. The Society has been the recipient of congratulatory praise by some of our University correspondents, for undertaking this service. As a further step a news article has been prepared describing this activity and offering copies of the bulletin to all interested.

At the present time an effort is being made to enlarge the coverage of research activities in graduate schools to the entire English-speaking world; and it is planned to include a survey of visual research now being conducted by non-educational institutions in the U.S.A. and Canada.

An attempt to work out item 3 was made by splitting the committee into two sub-committees. Sub-committe A, under the chairmanship of Professor H. O. Warner was asked "to identify, by means of a survey of the whole field of lighting, external to the Society, subjects which require scientific verification through research." Sub-Committee B, under the chairmanship of Sylvester Guth, was asked "to identify, by means of a survey of the Society's technical committees, those subjects that most urgently require scientific investigation and verification."

Neither sub-committee was able to make much progress in the short time intervening between appointment, and attendance at the general committee meeting for the purpose of preparing this report; but the research needs uncovered by both committees turned out to be similar. Under the heading of "basic" information needed are data dealing with the action of the visual sense, all the way from the reception

of light at the cornea, to the final evaluation of the information abstracted by the neurocortical system. Under the heading of "applied" information needed is amplification of performance data on illumination levels (such as extension of Weston's work, and verification of it), and data on what constitutes an optimum response of a human being to a visual stimulus, *i.e.*, under what lighting conditions does an individual feel most secure, see most clearly, enjoy maximum comfort, have to put forth the least effort, and in general, integrate his lighting response with all his other current responses to his environment, in the most effective way?

Most of the information needed can only be gained by research personnel outside of the field of lighting; and by research activities that must be carried on at levels beyond the equipment and training of members of the lighting fraternity.

The committee recommends to Council that a new feature be included in ILLUMINATING ENGINEERING, namely, "Abstracts of Current Research," in order that the membership may be kept abreast of research developments that affect them, by having such developments reported to them in language they can understand. The committee also recommends that the British, Australian, French and other friendly Societies serving the field of illumination receive copies of the bulletin giving summaries of current research, each time the bulletin is re-issued. Finally, the committee suggests that the list of research topics received by the committee be made available to educational institutions in the form of suggestions for theses, or dissertations.

Residence Lighting

E. W. Commery, Chairman

Based upon studies by committee members, two reports were prepared giving Recommended Levels of Illumination for Reading Piano Music and Hand Sewing in the Home. These reports were presented at the June Council meeting and accepted by Council's letter ballot.

During the current fiscal year a sub-committee completed its report, Contemporary Lighting in Modern and Traditional Interiors. Written in laymen's terms—for members, decorators and architects, the report is profusely illustrated, demonstrating how elements of modern lighting can be incorporated in traditional and modern interiors. This report also received Council's approval at the June Council meeting and began appearing (Part 1 of 3) in ILLUMINATING ENGINEERING in the September issue.

Also approved by letter ballot after presentation at the June Council meeting was the committee's report "The Functional Visual Activities in the Home and the Location and the Extent of the Associated Areas to be Illuminated," this section to replace Appendix B in the present report "Lighting Performance Recommendations for Portable and Installed Residence Luminaires."

A major accomplishment of the Committee was the complete review and revision of the Residence Lighting Section for the new edition of the IES Lighting Handbook.

Sports and Recreational Area Lighting

R. J. Swackhamer, Chairman

The committee's scope adopted this year differs from the assignment in previous years and taking the new scope which is quoted below the committee has made considerable headway.

"Develop current recommended practices for lighting sports and recreational areas; study techniques of application including effects on player performance and spectator visibility, and report thereon."

The committee has worked very diligently on the assignment. A tentative Recommended Practice was submitted, and was reviewed by the Technical Director. After a few minor changes and additions were made it was submitted to Council.

There is considerable additional work that this committee can and will do, such as studying individual applications and developing a more thorough understanding of vertical and horizontal footcandles as applied to sports and recreation lighting, spectator requirements, etc.

Store Lighting

D. P. Caverly, Chairman

The projects undertaken by the Store Lighting Committee included a revision of the section on Store Lighting in the IES Lighting Handbook and a revision of the Recommended Practice on Store Lighting.

At the first meeting, both of these tasks were discussed. In the opinion of the committee members the major difficulty with the present section on Store Lighting in the Handbook is the fact that the halftone illustrations are particularly poor. Also, it is believed that there are many new concepts of store lighting design which are not included in the existing section. Consequently, the copy and illustrations were discussed in detail and a first draft has been prepared with new illustrations, and is at the present time under consideration by all committee members.

Standards of Quality and Quantity for Interior Illumination

L. E. Barbrow, Chairman

The committee's principal efforts were directed toward the completion of a report intended to assist the application committees in setting up recommended levels of illumination. As the year closed this report, Number 5, "Performance as a Criterion of Quantity of Illumination," had been circulated to the Council for consideration at the first meeting in the new administration. The committee also has completed a revision of Section 2, Light and Vision of the IES Lighting Handbook.

Street and Highway Lighting

R. M. Zabel, Chairman

The Sub-Committee on Pavement Surfaces under the Chairmanship of F. D. Wyatt has continued its I.E.S. Research Fund sponsored work on the reflectance characteristics of pavement surfaces. Prof. J. O. Kraehenbuehl of the University of Illinois, who is carrying on this research project, has completed development and construction of the automatic measuring equipment and is now compiling readings on samples selected by the committee.

The Sub-Committee on Coordination, H. F. Ilgner, Chairman, has been active in preparing the Street Lighting Section of the new Institute of Traffic Engineers' Handbook.

The Sub-Committee on the American Standard Practice, under the Chairmanship of C. H. Rex has been especially active during the past year. The Sub-Committee's efforts on this project are nearing completion. Present decisions retain the basic illumination requirements of the existing

Standard Practice. Alterations in the Practice as they are now planned are in the interest of greater accuracy, understandability and simplification. The majority of a two-day April meeting of the Main Committee at Philadelphia was devoted to this subject.

The Research Sub-Committee with K. M. Reid as Chairman, has made arrangements with Prof. R. C. Putnam of Case Institute of Technology to undertake laboratory studies of discomfort glare under street lighting conditions. Excellent progress is being made.

A new Sub-Committee to study and report on the illumination of roadway signs has been appointed under the Chairmanship of J. L. Hays.

The Sub-Committee on Program and Publicity, under the Chairmanship of D. W. Rowten was instrumental in encouraging the presentation of five papers in an interesting Street Lighting Session at the Pasadena Technical Conference.

The Sub-Committee on revision of the Street Lighting Section of the IES Lighting Handbook under the Chairmanship of G. E. Korten, has completed its task by presenting the manuscript to the Chairman of the new Handbook Committee.

The Sub-Committee on Study Assignments on Accident Surveys was combined with the Sub-Committee on Public Lighting and Traffic Safety, both under the Chairmanship of G. K. Glass.

A task committee under the Chairmanship of R. M. Swetland prepared a chapter on Street Lighting for International City Managers Association. This material has just appeared in their handbook on Municipal Public Works Administration.

Mr. O. P. Ortlieb, a member of the committee, served as the society representative on the Highway Research Board and the Committee on Utilities and Trees of the National Shade Tree Conference.

Dr. R. M. Zabel, Chairman of the Committee, discussed street lighting and its application to their specific problems with the American Bridge, Tunnel and Turnpike Association.

Following the Pasadena Technical Conference the Committee held a joint two-day meeting with the Technical Sub-Committee of the Pacific Coast Electrical Association. Highlights of the meeting were discussions of the Standard Practice and a paper on fluorescent lighting of intersections.

Television

H. A. Kliegl, Chairman

Newly established this year the committee undertook the planning of a program under its joint objectives of studying and reporting the lighting for production of television programs and for the optical reception of television programs. Two subcommittees were formed: one on Lighting for Production of Television Programs under Chairman R. L. Zahour, and one on Lighting for Television Reception under Chairman E. W. Commery. The latter held one meeting in July and mapped out a program of study. Several vision researchers have made preliminary studies and more laboratory study is planned.

The task group in the Lighting for Production of Television Program Committee met three times and has developed a report entitled "Current Lighting Practice for Television Production" which is being presented to Council at the December Council meeting.

As the year drew to a close, it was decided to cooperate closely with similar activities in the Society of Motion Picture and Television Engineers.

Testing Procedures for Illumination Characteristics

Ray P. Teele, Chairman

The committee started the year with five projects under consideration:

Preparation of a guide for field measurements of floodlighting.

Preparation of a guide for field measurements of street and highway lighting.

Review for revision report on photometric testing of floodlights and narrow beam projectors.

Review for revision report on photoelectric photometers.

Review for revision that section of the IES Lighting Handbook pertaining to testing procedures.

The first two had so much in common that they were combined into a single guide entitled, IES Guide for Outdoor Illumination Tests—Part I—Street and Highway Lighting; Part II—Baseball and Football Fields (Other Sports Areas). This was submitted to Council and accepted.

The third project "IES Guide for the Photometric Testing of Floodlights of 10 to 160 Degrees Total Beam Spread" was submitted to Council and approved by letter ballot.

No work was done on the revision of the report on photoelectric photometers. The revision of the IES Lighting Handbook being given priority over this item. A revised section 5 of the Handbook was prepared and sent to the Handbook Revision Committee.

The "Specifications for Testing Lighting Equipment, Section 1, Specification No. C-1-1940, Luminaires for General Lighting," which was published in ILLUMINATING ENGINEERING, Vol. XXXV, No. 3, March 1940, was revised to take into consideration the "ring-type" luminaire. This revision will be submitted to Council.

A project which the committee has had in mind for some time is a round robin test of fluorescent lamps. The methods given in IES Guide for Photometric Testing of Fluorescent Lamps—1949 are to be followed by the various testing laboratories. Groups of lamps have been seasoned and are at the first laboratory where measurements will be made.

The committee also reviewed for revision Section 40 of ASA Z7. This was done at the request of the I.E.S. Committee on Nomenclature and a summary of the suggested changes has been sent to this committee.

TELECAST

LIGHTING NEWS OF CURRENT INTEREST

Summary of Council Executive Committee Action

The Society's Council Executive Committee held its first meeting of the new administrative year on November 8, 1950, in Cleveland, Ohio. Present were: Walter Sturrock, President; E. M. Strong, Vice-President; S. G. Hibben, Vice-President; A. H. Marwaring, General Secretary; R. F. Hartenstein, Treasurer; A. D. Hinckley, Executive Secretary; and R. N. Green, H. A. Lawrence, and F. E. Mueller.

Action was taken, on the recommendation of the General Board of Examiners to elect to Society membership, 73 Members, and 13 Student Members, a complete list of which has been published in the back pages of this issue of the Telecast Section. Other changes in membership, bring the current totals to those shown in the following tabulation:

September 30, 1950		November 8, 1950
7057	Total Membership	7182
33	Members Emeritus	33*
40	Fellows	40
1610	Members	1631
5005	Associate Members	5087
369	Student Members	391

*Includes 9 Fellows of the Society.

The Committee gave further study to Standing and technical committee appointments, confirming a number of additions and other changes in committee personnel.

Local Activities

E. M. Strong, Chairman of the Local Activities Committee reported on the procedure being followed in appointing Local Representatives to carry on the Society's objectives in numerous cities and towns throughout the U.S. and Canada, working in close contact with the Regional Vice-Presidents and the Sections and Chapters.

President Sturrock described his plans for attending the Regional Conferences scheduled in seven of the Society's Regions, indicating that he plans also to visit a number of Sections and Chapters in the course of his travels. He indicated that efforts have been successful in coordinating the dates of Regional Conferences during the current year, recommending at the same time that insofar as possible dates and locations of Regional Conferences be planned two years in advance. Discussion on the subject of assistance to new Chapters concurred with the approval of the Committee on the President's Address to the effect that all possible aid should be given new Chapters following their establishment. This matter was referred to the Local Activities Committee for action.

Referring to the recommendation that two Board Members in each of the Sections and Chapters be elected for a two-year term, President Sturrock noted the concurrence of the President's Address Committee on this recommendation. Discussion covered the possible advantages in long-term experienced Board Members, and on the other hand the advantages of more rapid turn-over. Action was taken to refer the matter to the Committee on Local Activities for further study as to final recommendation.

Northeastern Region Holds Autumn Conference in New York

Planners for next spring's scheduled Regional Conferences have a chance, this year, to look over the experience of one Region for successful ideas. The first I.E.S. Regional Conference of the 1950-1951 season took place in New York City, October 26 and 27, under the auspices of the Northeastern Region — the autumn timing in itself an innovation.

In the past several years all of the Society's Regional Conferences have grown to "convention" proportions. The most successful ones have required the same "convention" type of committee structure and advance planning. Serious planning and hard work paid off for Northeastern's Regional Conference. The papers program was of exceptional value to a wide range of interests; housing, transportation and entertainment effortlessly handled.

Ten Ideas Worth Stealing

1. The printed program of attractive 8½ x 11" format was also attractively available in pocket-size — simply photo-offset the original in reduced size.

2. Mimeographed sheets listing worthwhile lighting installations to visit after the days' sessions were given to all visitors at the conference.

3. Members of the Section conducted Post-Convention tours the following Saturday, to see the city's best examples of planned lighting.

4. Sustaining Members of the Northeastern Region competed for a certificate award for the most outstanding display panel. These interesting displays were set up in the foyer leading to the Statler Hotel auditorium in which technical sessions were held, and received much attention from delegates during the two-day meeting.

5. Luncheon tickets purchased from the Statler Hotel in advance were included with the Conference fee, providing a convenient and quick method for delegates to lunch together on the conference premises.

6. Representatives of five different utility companies in the Region reported how their companies conducted planned lighting programs—each different—each rich with new ideas.

7. A contest for "My Most Interesting Job"—an idea already "stolen" from other Regions, but well worth extending to all conferences.

8. Three *users* of lighting—customers to you—discussed why he chose the lighting he did. A show of hands vote indicated delegates would find such discussions of even more value possibly, than the same subject from a lighting man.

9. Match folders promoting the I.E.S. National Technical Conference to be held August 26-30, 1951, Hotel Shoreham, Washington, D. C.

10. One hundred tickets to "South Pacific" and an additional 100 tickets to five other Broadway hits were purchased by the Conference Committee months ahead, for the convenience of Conference visitors. This idea may be peculiar to New York meetings, but adaptable elsewhere as well.

Opening Session

Features of the opening session, m.c.'d by Carroll O'Shea, New York Section Chairman, included addresses by Walter Sturrock, I.E.S. National President, Richard G. Slauer, Northeastern Regional Vice-President, and J. C. Forbes, Conference Chairman.

C.C.N.Y. Charter

Two ceremonies of special interest also were a part of the opening program. One was the presentation of the C.C.N.Y. Student Branch Charter to Professor Abraham Abrahamowitz, faculty advisor for the new I.E.S. Student Branch at City College of New York. The Charter was presented by Regional Vice-President Slauer, with C.C.N.Y. members Arthur Sealman and Jacques Slesinger also participating in the presentation.

Honorary Membership Presented To Dr. Harrison

A most impressive feature of the opening session was the presentation to Dr. Ward Harrison of a certificate of Honorary Membership in the Illuminating Engineering Society, London, British counterpart of the Society in this country. The presentation was made by the President of the British Society, Mr. L. J. Davies, Director of Research, Thompson Houston, Ltd., who was visiting this country at the time of the Conference.

In making the presentation of this highest honor which can be awarded by the British Society, Mr. Davies stated that no other American has been so honored and read the following citation: "The Council of the Illuminating Engineering Society, being empowered by the Articles of Association and the By-Laws of the Society to elect as an Honorary Member anyone who is of acknowledged eminence in some branch of science relating to Illuminating Engineering or who by reason of position, eminence or experience has rendered signal service in promoting the objects of the Society, (providing the number of Honorary Members shall not at any time exceed six) has conferred Honorary Membership upon Dr. Ward Harrison in acknowledgment of his numerous and valuable contributions to the advancement of the art and science of lighting and in recognition of the eminence he has attained thereby."

Dr. Harrison was the recipient of the I.E.S. Gold Medal at its 1949 Annual Conference in French Lick. He is a fellow of the Illuminating Engineering Society and 18th President. He was the first to receive the honorary degree of Doctor of Illuminating Engineering awarded him in 1940 by the Case School of Applied Science.

For nearly two decades as director of engineering of the Lamp Department of the General Electric Company, he was in charge of the largest illuminating engineering organization in the world.

HONORARY MEMBERSHIP in the Illuminating Engineering Society of Great Britain was formally presented to Dr. Ward Harrison, right, at the opening session of the Northeastern Regional Conference, New York City. Presenting the certificate for this very high honor is Mr. L. J. Davies, President of the British I.E.S.

A luncheon was later held in honor of Mr. L. J. Davies, sponsored by President Walter Sturrock. Society officers and members present to honor Mr. Davies included:

Professor E. M. Strong
Mr. L. A. Hobbs
Mr. A. A. Brainerd
Mr. C. L. Crouch
Mr. Anthony W. Deller
Mr. C. H. Goddard
Dr. Ward Harrison
Mr. A. D. Hinckley
Mr. H. H. Magdsick
Mr. H. B. Peirce
Mr. Walter Sturrock
Mr. A. F. Wakefield
Dr. R. M. Zabel
Mr. S. G. Hibben
Mr. F. G. Slauer

Papers Program

1. The I.E.S. Progress Committee's popular **"Parade of Progress"** report, as put on at Pasadena, was repeated for the benefit of delegates to the Northeastern Regional Conference. The demonstration was made, of course, in inimitable Rodgerian fashion by Alston Rodgers, Chairman of the Committee. A new note, though, was a very tall Indian (Jim Forbes) in full war paint, interrupting the demonstration to show lighting progress in the wigwam. (See illustration.) Progress included 8-foot T-12 lamps as lodge poles, heat lamps for infra-redskin, and TV in the tepee. His Indian blanket, of course, had to be unplugged before he could leave the stage.

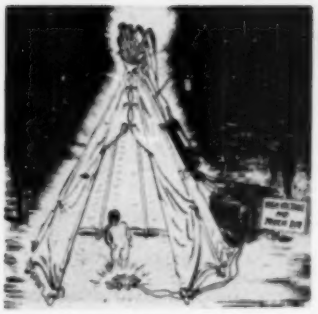
2. **Lighting and Color** — Three prominent *users* of light discussed his choice of light sources for merchandise and display, with George J. Taylor of Day-Brite Lighting Inc., serving as discussion leader.

Richard C. Belcher, architect of the R. H. Macy department store demonstrated with colored sports shirts why he found that, in one particular branch at least, 40-watt standard warm white fluorescent eliminated completely merchandise returned because of color disappointment.

Robert E. Myers, Mohawk Carpet Mills, outlined his company's experience in studies on the best type of display lighting. He noted that a survey showed color the first basis for choice in buying carpets, and said they had found color dissolves past 45 footcandles of light. His recommended value was of the order of 25 footcandles, 12" from the floor. Incandescent lighting will be recommended for display rooms, he said, as long as its use in homes is more prevalent than fluorescent.

L. S. Harrison, consulting engineer of Metropolitan Museum of Art, New York, demonstrated, with several paintings, why a combination of incandescent and fluorescent sources gave the most faithful reproduction of color for art exhibition.

3. **Contemporary Lighting for Modern and Traditional Interiors**, a Residence



LIGHTING PROGRESS in the wigwam, as shown at the Northeastern Regional Conference.

Lighting Committee report designed to be of especial value to decorators and home lighting practitioners, was described in detail by Miss Myrtle Fahsbender, Westinghouse Electric Corp., Bloomfield, N. J., who was Chairman of the Sub-Committee making the study. The 60-page booklet described will be available from I.E.S. Headquarters soon after the first of the year.

4. **Fluorescent Lighting in the Home**—from the viewpoint of the smaller budget was ably presented by Miss Lillian Eddy of General Electric Co., Lamp Department, New York.

5. **Planned Lighting**, with the keynote address by Ralph P. Wagner, Chairman of the Better Light Better Sight Bureau opened a most interesting session, in which five utility representatives described their companies' programs. Participating were:

T. A. Tellefson, Rockland Light & Power Co., A. R. Hampsey, Jr., Duquesne Power & Light Co., Pittsburgh, C. D. Hollister, Niagara Mohawk Power Co., Albany, N. Y., W. J. Schmidt, Long Island Lighting Co., Taylor Barr, Central Hudson Gas & Electric Co., Poughkeepsie, N. Y.

6. **Luminous Ceilings Combined with Radiant Heating**, was discussed and demonstrated by Dr. Domina Eberle Spencer of Brown University, and L. F. Martin of the Martin Electric Products Co., Inc., Sommerville, Mass.

7. **Mercury Lighting**—Color Correction and Other Improvements, by J. R. Jones and W. S. Till of the Westinghouse Electric Corp., Bloomfield, N. J., demonstrated the recommended type of mercury lamps for various industrial applications.

8. **Analysis of Glare Appraisal Systems**, by C. L. Crouch, Technical Director of I.E.S., was a most interesting comparison of the glare appraisal methods of Holladay, Harrison, Guth and Fetherbridge-Hopkinson.

LIGHTING CALENDAR

Society Events

December 14, 1950 — Meeting of I.E.S. National Council, Hotel Lexington, New York, N. Y.

February 8, 1951 — Meeting of I.E.S. National Council, New York, N. Y.

March 4-6, 1951 — Southwestern Regional Conference, Driscoll Hotel, Corpus Christi, Texas

March 19-24, 1951 — Pacific Northwest Regional Conference, Spokane, Wash.

April 5, 1951 — Meeting of I.E.S. National Council, Chicago, Ill.

April 9-12, 1951-Southern Regional Conference, Atlantis Hotel, Miami Beach, Fla.

May 9-12, 1951 — Canadian Regional Conference, Chateau Frontenac, Quebec

May 14, 1951 — Midwestern Regional Conference (Hotel and City not yet announced).

May 24-25, 1951—Great Lakes Regional Conference, Cincinnati, Ohio

June 14, 1951 — Meeting of I.E.S. National Council, New York, N. Y.

August 26-30, 1951—Illuminating Engineering Society, National Technical Conference, Hotel Shoreham, Washington, D. C.

Industry Events

December 26-30, 1950 — 117th Meeting of the American Association for the Advancement of Science, Cleveland, Ohio

January 15-18, 1951 — Plant Maintenance Show, Cleveland, Ohio

January 22-25, 1951 — The American Society of Heating and Ventilating Engineers, 57th Annual Meeting, Philadelphia, Pa.

January 23-26, 1951—Winter General Meeting, American Institute of Electrical Engineers, New York

February 5-7, 1951—National Electric Sign Sign Association Convention and Exhibit, Hotel New Yorker, New York, N. Y.

February 28, 1951 — Inter-Society Color Council, Annual Meeting, Washington, D. C.

March 5-9, 1951 — Spring Meeting and Committee Week of the American Society for Testing Materials, Cincinnati, Ohio

March 12-15, 1951 — National Electrical Manufacturers Association, Edgewater Beach Hotel, Chicago, Ill.

April 2-5, 1951 — The American Society of Mechanical Engineers, Spring Meeting, Atlanta, Ga.

April 3-5, 1951 — 17th Annual Sales Conference, Edison Electric Institute, Edgewater Beach Hotel, Chicago, Ill.

April 3-6, 1951—Greater New York Safety Council 21st Annual Safety Convention & Exposition, Hotels Statler and Governor Clinton, New York, N. Y.

April 9-11, 1951—The Electrochemical Society Inc. Convention, Washington, D. C.

April 30 - May 4, 1951—The Spring 1951 convention of the Society of Motion Picture and Television Engineers, Hotel Statler, New York, N. Y.

May 7-11, 1951 — National Fire Protection Association, Annual Meeting, Hotel Statler, Detroit, Mich.

May 9-12, 1951 — Canadian Regional Conference, Chateau Frontenac, Quebec Canada.

May 17-19, 1951 — Public Utilities Advertising Association, Hotel New Yorker, New York, N. Y.

Week of May 20th, 1951 — National Association of Electrical Distributors, Atlantic City, N. J.

June 4-7, 1951 — Edison Electric Institute, 19th Annual Convention, Denver, Colorado

June 11-15, 1951 — The American Society of Mechanical Engineers, Toronto, Ont., Canada

June 25-29, 1951—Summer General Meeting, American Institute of Electrical Engineers, Royal York Hotel, Toronto, Ont., Canada

August 26-30, 1951 — I.E.S. National Technical Conference, Hotel Shoreham, Washington, D. C.

September 25-28, 1951 — Fall Meeting, The American Society of Mechanical Engineers, Minneapolis, Minn.

October 8-12, 1951 — 39th National Safety Congress & Exposition of the National Safety Council, Chicago, Ill.

October 15-19, 1951—Fall 1951 convention of the Society of Motion Picture and Television Engineers, Hollywood-Roosevelt Hotel, Hollywood, Calif.

November 12-15, 1951 — National Electrical Manufacturers Association, Chalfonte-Haddon Hall, Atlantic City, N. J.

November 25-30, 1951 — Annual Meeting, The American Society of Mechanical Engineers, Atlantic City, N. J.

MY MOST INTERESTING JOB

Judges for the contest for "My Most Interesting Job" were Chairmen of the three Sections comprising the Northeastern Region, Carroll O'Shea, New York; R. M. Hendrickson, Connecticut; and John W. Young, New England. So difficult was their choice from the six excellent jobs presented, that they named two as winners. Top awards went to Fred Hill, Consulting engineer, New Haven, Conn., for the lighting of a bank which had been converted from a church; and to Willard Thompson, Thompson Engineering Co., Boston, Mass., for the lighting of Boston's Museum of Art.

Runners-up included:

Lighting the Jordan Walsh Store by George L. Ely (honorable mention).

Fluorescent Cove Lighting in a Church, by Frank E. Brown, Day-Brite Lighting Co., Stratford, Conn.

Lighting an Office by Walter S. Green

wood, Public Service Elec. & Gas Co., Newark, N. J.
Lighting a Hospital Bed, by B. F. Greene, New York City.

ENTERTAINMENT

A complete Ladies' Program was conducted throughout the Conference, under the direction of Miss Lillian Eddy. Large numbers of visiting ladies took a sightseeing boat trip around the island of Manhattan, visited broadcasting stations, and of course, in the kingdom of merchant princes that is New York, shopped with Section members as guides.

A departure from the conventional Presidents' Night dinner dance, was the Conference party held at the "Village Barn," a famous N. Y. night spot in Greenwich Village.

COMMITTEE

The effortless manner in which 252 delegates and guests enjoyed such an outstanding Conference, was due to the efficiency and efforts of the following people, and 42 members of their committees.

Richard G. Slauer ..... Regional Vice-President
J. C. Forbes ..... Conference Chairman

M. Waterman ..... Papers
H. Keene ..... Finance
G. Taylor ..... Attendance
Lillian Eddy ..... Ladies' Entertainment
J. Arthur ..... Hotel
D. Caverly ..... Entertainment
J. Krieger, R. DeCew ..... Publicity
T. Collins ..... Registration & Reception
R. Zahour ..... Decoration & Tickets
J. Slevin ..... Transportation

I.E.S. Represented at U. of N. H. Dedication

The Illuminating Engineering Society was invited to send a representative to the dedication ceremonies which opened Kingsbury Hall, a new million dollar structure recently added to the College of Technology at the University of New Hampshire. Mr. Omer W. Bureau, an active I.E.S. member in Durham, New Hampshire, served as the Society's representative at this historic meeting. The new building, the largest on the Campus, was named for the late Professor Albert Kingsbury, a noted engineering instructor and inventor, at New Hampshire University.

The plaque in memory of Professor Kingsbury was presented by his family to the University for display in the new building. A Kingsbury Memorial Fund, contributed by alumni who were the late Professor's students, was also turned over to the University as part of the ceremonies. The money is to be used for an annual award to an engineering student.

U. S. National Committee, I.C.I. Holds Annual Meeting, New York

The annual meeting of the U. S. National Committee of the International Commission on Illumination was held in New York City on November 16. Among other significant business conducted by the Committee was the re-election of the 1949-1950 officers. Elected to serve again next year were:

President — Arthur A. Brainerd
Vice-President — Willard C. Brown
Secretary — Louis E. Barbrow
Treasurer — Rudolf W. Stand

It was noted, in connection with the meeting that 45 delegates and guests from the United States will make the trip to Stockholm, Sweden to attend the annual sessions of the I.C.I. to be held there from June 25 to July 4, 1951. Of these, 25 will be official delegates representing every branch of the lighting industry. Technical papers by five prominent American lighting experts have been selected for presentation at Stockholm. The papers selected include: "The Engineering Evolution of the Fluorescent Lamp" by Dr. E. F. Lowry, Sylvania Electric Products Inc.; "Space Concepts of Lighting," by R. G. Slauer, also of Sylvania Electric; "The Subjective Appraisal of Brightness," by S. K. Guth, General Electric Co.; "Daylight in Classrooms" by Prof. R. L. Biesele, Jr., Southern Methodist University; and "Home Lighting Practice" by Miss Myrtle Fahsbender of Westinghouse Electric Corp.

It was also announced that new offices of the I.C.I. (Central Bureau) have been opened at 570 Lexington Ave., New York City, under the direction of Secretary General R. J. Whitney. Mr. Whitney will be assisted by Miss Audrey Wiggins, who was formerly attached to the Central Bureau in England.

The committee soliciting sustaining memberships in I.C.I., headed by Miss Clara H. Zillessen, reported to the annual meeting on progress in this connection. A newly prepared booklet was presented, to be featured in two colors, titled "The International Commission on Illumination — Its Aims, Its Accomplishments." This new booklet is generally considered the best piece of its kind since the founding of the organization in 1900.

Considerable expansion of the work of the I.C.I. was indicated during discussions at the meeting. Nineteen countries are now represented by national committees. In addition, it is anticipated that Finland will be admitted at the Stockholm meetings. National committees are now being formed in Israel, Ireland and Brazil.

In recognition of the outstanding contributions made by Dr. E. C. Crittenden to the work of the U.S. National Committee, and to the work of the I.C.I., over a period of many years, Dr. Crittenden was elected an Honorary Life Member of the U. S. National Committee. The official announcement of this honor will be made on December 19 at a banquet to be held by Dr. Crittenden's colleagues at the National Bureau of Standards in honor of his retirement.

CENTRAL New York Chapter featured an outstanding extension meeting this fall, at the Corning Glass Works, Corning, N. Y. Majority of the members traveled more than 100 miles to see Dr. W. W. Shaver's demonstration of new glass developments. Shown at the speaker's table at the dinner meeting also featured are: (l. to r.) Dr. Henry Phelps Gage, Member Emeritus; A. S. Tylor, Dr. W. W. Shaver, A. H. Clarke, Chairman of Central New York Chapter, E. M. Strong, I.E.S. Vice-President, E. C. Edwards, J. P. Hoxie, and Dr. C. L. Cottrell.

Last Call for Medal Nominations

G. W. Beals, Chairman of the 1951 Medal Committee, has issued the last call inviting all members to send in nominations for consideration by the Committee. These must be received by January first, 1951, for consideration by the present Committee. Each nomination should be accompanied by a comprehensive statement of the candidate's achievements, whether they be in the field of engineering, design, applied illumination, optics, ophthalmology, lighting research, education, or administration and management. Nominations should be sent to the I.E.S. Medal Committee, in care of the General Offices of the Society. Inquiries concerning nominations may be addressed to the Executive Secretary, A. D. Hinckley.

Back Issues of Transactions Available

Sets of ILLUMINATING ENGINEERING and its predecessor, *Transactions of I.E.S.*, from November 1938 to January 1949 inclusive are available for sale from an Iowa Section member. Anyone interested in obtaining these issues may contact R. B. Miller of the Iowa-Illinois Gas and Electric Co., Davenport, Iowa.

NEW MEMBERS

At the meeting of the Council Executive committee held in Cleveland, Ohio, on November 8, 1950, the following were elected to membership:

CAPITAL SECTION

Associate Member:
Walker, A. G., Jr., Robert L. Brown & Associates, Roanoke, Va.

CAROLINAS CHAPTER

Member:
Swaim, B. C., Biberstein & Borries, Inc., Charlotte, N. C.

CENTRAL NEW YORK CHAPTER

Associate Members:
Caryl, Robert, Donohoe & Caryl, Syracuse, N. Y.
Gott, A. H., Corning Glass Works, Corning, N. Y.

CHICAGO SECTION

Members:
Hart, H. A., Henry A. Hart & Associates, Chicago, Ill.
Malone, J. C., Sylvania Electric Products Inc., Chicago, Ill.

Associate Members:
Abrell, C. W., Edward P. Allison & Co., Chicago, Ill.
Benbow, G. L., Benjamin Electric Mfg. Co., Des Plaines, Ill.
Briner, Donn, Sears Roebuck & Co., Chicago, Ill.
Cohn, Marvin, Hub Electric Co., Chicago, Ill.
Craig, C. W., Westinghouse Electric Corp., Cleveland, Ohio
Heumann, Karl, Public Service Co. of Northern Ill., Glencoe, Ill.
Henslein, A. H., Public Service Co. of Northern Ill., Maywood, Ill.
Hollingsworth, F. H., Illinois Bell Telephone Co., Chicago, Ill.
Lundberg, H. H., Wadeford Electric Co., Chicago, Ill.
Nesvig, E. M., General Electric Co., Chicago, Ill.
Pacer, E. L., Holabird & Root & Burgee, Chicago, Ill.
Pryor, Henry, Curtis Lighting Corp., Chicago, Ill.
Pudewill, C. J., D. William Fuller Co., Chicago, Ill.
Sanders, Kerr, Jr., Chicago Lighting Institute, Chicago, Ill.
Schleicher, G. W., Holabird & Root & Burgee, Chicago, Ill.
Van Dermark, Lloyd, Schmidt Garden & Erikson, Chicago, Ill.

Student Members:
Burke, J. J., University of Illinois, Urbana, Ill.
Christensen, Morgan, University of Illinois, Urbana, Ill.
Federman, A. D., University of Illinois, Urbana, Ill.
Larsen, P. W., University of Illinois, Urbana, Ill.
Lemke, R. H., University of Illinois, Urbana, Ill.
Leuthold, D. W., University of Illinois, Urbana, Ill.
Mikita, T. E., University of Illinois, Urbana, Ill.
Richards, B. D., University of Illinois, Urbana, Ill.

CLEVELAND SECTION

Associate Members:
Mayfield, V. R., The Electric Sales Co., Canton, Ohio
Oerkvits, C. A., Westinghouse Electric Corp., Cleveland, Ohio
Whitwell, O. D., Case Institute of Technology, Cleveland, Ohio
Wilder, J. D., The Ohio Power Co., Newark, Ohio

FOREIGN NON-SECTION

Associate Member:
Van Wameln, M. A., Government of Netherlands Antilles, Dept. of Public Works, Curacao, N. A.

GEORGIA SECTION

Member:
Hammond, J. O., The Union Metal Mfg. Co., Decatur, Ga.

Associate Members:
Johnson, W. F., Georgia Power Co., Atlanta, Ga.
McDaid, J. P., Globe Lighting Products, Inc., Brooklyn, N. Y.

HEART OF AMERICA SECTION

Associate Member:
Hoss, D. C., State of Kansas, State Architects Office, Topeka, Kans.

INDIANA CHAPTER

Associate Member:
Wolfe, M. B., Public Service Co. of Ind., Inc., Terre Haute, Ind.

INLAND EMPIRE CHAPTER

Associate Member:
Ruffatto, John, Columbia Electric & Mfg. Co., Spokane, Wash.

IOWA SECTION

Associate Members:
Holcombe, R. C., Interstate Power Co., Dubuque, Ia.
Maiwald, C. R., Swanson & Maiwald, Moline, Ill.

MICHIGAN SECTION

Member:
Roughley, T. H., The Detroit Edison Co., Detroit, Mich.

Associate Member:
Pleasants, L. P., Sylvania Electric Products Inc., Detroit, Mich.

MILWAUKEE CHAPTER

Associate Members:
Christopherson, N. C., Electrical League of Milwaukee, Milwaukee, Wis.
Spaude, W. C., Northern Light Co., Milwaukee, Wis.
Waechter, H. C., Ed Schuster Co., Milwaukee, Wis.

NEW YORK SECTION

Member:
Nachtigall, Fred, Mullikin & Dietrich, Inc., New York, N. Y.

Associate Members:
Hastings, Warren, Benjamin Electric Mfg. Co., New York, N. Y.
Masterson, R. A., Public Service Electric & Gas Co., Perth Amboy, N. J.

Student Members:
Hiumensto k, Alexander, City College of New York, New York, N. Y.
Novik, Walter, City College of New York

NORTHERN CALIFORNIA SECTION

Student Members:
Ertukel, R. F., Stanford University
Exarchou, N. J., Stanford University
Zopf, D. O., Stanford University

NORTHWESTERN OHIO CHAPTER

Associate Members:
Harms, G. B., Eggleston & Son, Toledo, Ohio
Hart, C. E., Jr., Central Ohio Light & Power Co., Findlay, Ohio
Kuehnle, G. D., Gross Electric Fixture Co., Toledo, Ohio
Selby, Wanda C., Toledo Edison Co., Toledo, Ohio
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Zimmerman, J. W., Abbott Lighting Co., Toledo, Ohio

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General Electric announces conceived to improve

CREATES A NEW CONCEPT IN LIVING . . .

THE "LIGHT-CONDITIONED" HOME!

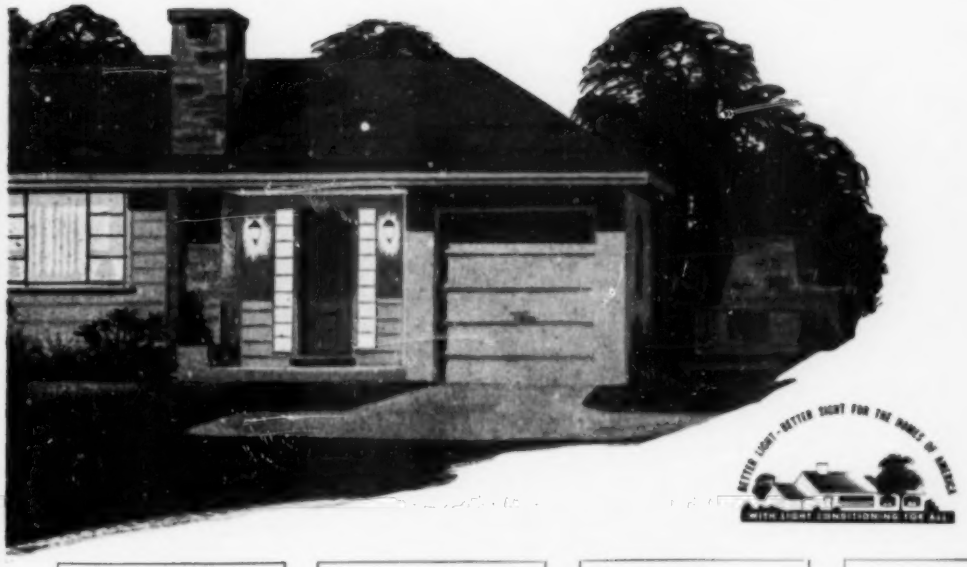
HERE'S the home lighting program that utilities, fixture makers, lighting dealers and contractors have been waiting for! It's General Electric's Home Light-Conditioning Program—aimed at raising the standards of lighting in both new homes and old!

The Home Light-Conditioning Program is built around a set of authoritative, comprehensive lighting recipes, prepared by General Electric home lighting specialists and based on studies made by the Illuminating Engineering Society. They cover virtually every conceivable lighting situation. They point the way to a *new kind* of home comfort and beauty—the "Light-Conditioned Home" that's as bright and inspiring as all outdoors. And with lighting fixtures and lamps on the market to implement the recipes, the way is wide open for the greatest advance in home lighting since the adoption of the incandescent lamp.

Backed by General Electric's national advertising, plus local promotion by utilities, contractors, and dealers, the Home Light-Conditioning Program is now underway. For full information on how you can tie-in to make the most of the program, see your nearest G-E Lamp District Office. General Electric Company, Lamp Department, Nela Park, Cleveland 12, Ohio.

GE LAMPS

the greatest program ever home lighting!



Prepared by General Electric for broad distribution, the "Light-Conditioning Recipes" book gives detailed information for lighting every room. Available at cost.

General Electric's national magazine, radio, and television advertising backs up the Light-Conditioning Program. Ads will appear in Saturday Evening Post, Ladies Home Journal, Better Homes & Gardens.

To help promote the program in your own territory, General Electric offers a set of advertising mats for use in local newspapers.

See the November issue of Better Homes and Gardens for a feature article on Light Conditioning. Reprints are available.

GENERAL ELECTRIC

Only a LABEL

. . . but it means your constant assurance of uncompromised quality!

Each ADVANCE BALLAST must pass the most exhaustive tests for efficiency . . . the most rigid examination for perfection of workmanship . . . the most careful inspection . . . before the ADVANCE LABEL is affixed.

One of a complete line of FLUORESCENT BALLASTS.

The Best Ballast Buy

CABLE ADDRESS: ADTRANS

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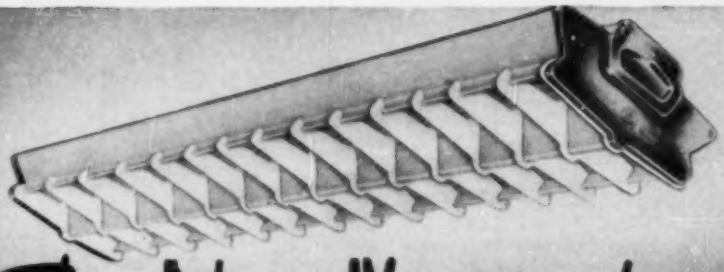

The New "Lenox Look"

FOR STORE LIGHTING

NOW! LUMINOUS PLASTIC SIDES!

Good looking? You've never seen such style and beauty in a fluorescent store lighting fixture before! The smartly designed "Lenox" series, now available with extruded plastic side panels, retains all its high efficiency and low brightness ratios—and adds soft, diffused side lighting to enhance its elegant appearance. The "Lenox"—for two or four 40-watt lamps—surface or suspension mounting—continuous or unit installations.

ACCENT UNITS

Adjustable or fixed accent units available for inclusion in "Lenox" runs or at the ends of runs.

and the Usual Day-Brite Premium Quality

...WITHOUT PREMIUM COST!

The "Lenox," like all Day-Brite fixtures, gives you *extra value*—example: interlocked louvers for extreme strength and rigidity; example: NO-BLINK type starters; example: HOT-BONDED SUPER WHITE enamel finish.

These and the many other famous Day-Brite top-quality features are standard equipment—*at standard prices*. Dollar for dollar, you can't equal Day-Brite's long-term, trouble-free performance at the lowest possible installation, maintenance and operating cost.

Write today for the complete "Lenox" story. Address: Day-Brite Lighting, Inc., 5432 Bulwer Ave., St. Louis 7, Mo. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.

036

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DAY-BRITE

Lighting Fixtures

DISTRIBUTED NATIONALLY
BY LEADING ELECTRICAL WHOLESALERS

MITCHELL
module
REG. U.S. PAT. OFFICE

lights them ALL!

From coast to coast and border to border, MITCHELL MODULE is lighting America's stores, offices and institutions. MODULE has conclusively demonstrated its amazing adaptability to *all* commercial lighting demands—has proved its ability to provide smooth, custom-fitting, high-efficiency lighting at unprecedented low cost.

See the proof now—in actual photographs. Get your copy of MODULE IN ACTION—the new booklet that illustrates a cross-section of actual MODULE installations, representative of hundreds now in service—telling *proof* of extraordinary lighting superiority and flexibility. Here are ideas galore for contractors, architects, utility representatives—a clinching demonstration for lighting salesmen. See how MODULE *lights them ALL*—send today for your free copy of MODULE IN ACTION.

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MITCHELL MANUFACTURING COMPANY
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City_____ *Zone*_____ *State*_____

*Attention*_____

New CORNING
Twin-lite Lens Panels
IN BANK OF NOVA SCOTIA BUILDING

Added Beauty
Improved Brightness Control

As one of the best examples of modern office building design, it is only fitting that the Bank of Nova Scotia Building in Toronto should be equipped with the latest thing in lightingware—new Corning Twin-lite Lens Panels. A product of Corning research, this important new medium for fluorescent lighting adds beauty and improved brightness control to any installation. The lenses in these water-white crystal lenses are scientifically designed to give a substantial reduction in side and luminaire brightness.

Corning Light-Weight Lens Panels are lower in cost than previous products of this type. For example, two 24" frame mounted Uni-lite or Twin-lite panels will mean a saving in glass cost of nearly 12% over four of the old shorter length panels. Reduction in weight means easier mounting and installation, while the added feature of variable lengths widens the field of application.

Corning Light-Weight Lens Panels are available 11" wide and up to 48" in length in both Twin-lite and Uni-lite patterns. Longer lengths and special widths can be supplied on order. Take advantage of the possibilities offered by this truly new lightingware. Write for information today.

CORNING GLASS WORKS
CORNING, NEW YORK
Corning means research in Glass

FOR EFFICIENT, ATTRACTIVE LIGHTING . . .
CORNING ALBA-LITE for diffusion of fluorescent light . . . CORNING FOTA-LITE for high level illumination . . . CORNING brand LENS PANELS and PYREX brand LENSLITES for prismatic light control

CORNING GLASS WORKS
Dept. IE-12, Corning, N. Y.

Please send complete information on Corning Twin-lite and Uni-lite Lens Panels.

Name _____ Title _____

Firm _____

Address _____

City _____ Zone _____ State _____

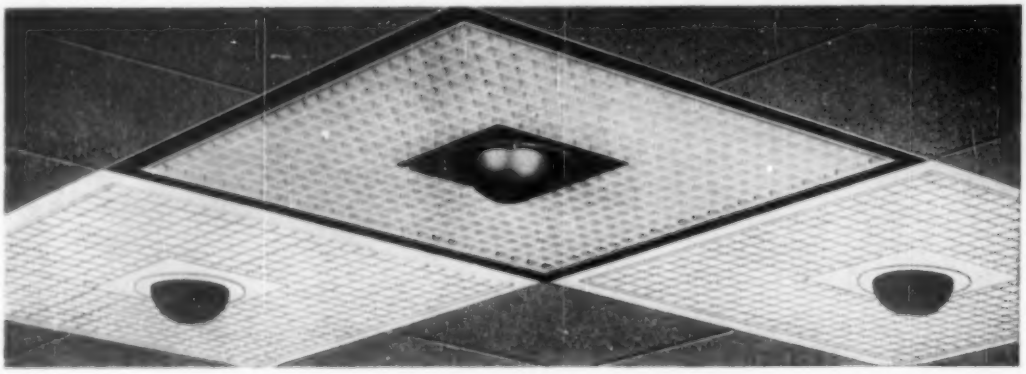
Orders for Skylike® are piling sky-high!

Silvray **SKYLIKE*** lighting – introduced a few months ago – has excited everyone in the business: user, architect, contractor, lighting engineer. Orders are piling up faster than we can fill 'em – but we're doing our best!

The problem is, steel is as hard to buy as **SKYLIKE** is easy to sell. The Silvray Lighting purchasing department just can't find steel fast enough to keep up with the skyrocketing popularity of this brilliant new concept of commercial lighting. The outlook varies from week to week, however, so don't hesitate to inquire about deliveries. Silvray **SKYLIKE** units are being produced – and orders are being filled – just as fast as conditions permit.

Meanwhile, we'll gladly send you a copy of the fully descriptive catalog, "Skylike Louvered Incandescent Lighting Systems". Write to *Room 1516, Graybar Electric Company, Inc., 420 Lexington Ave., New York 17, N.Y.*

*Patent pending



Why so many businesses want Skylike

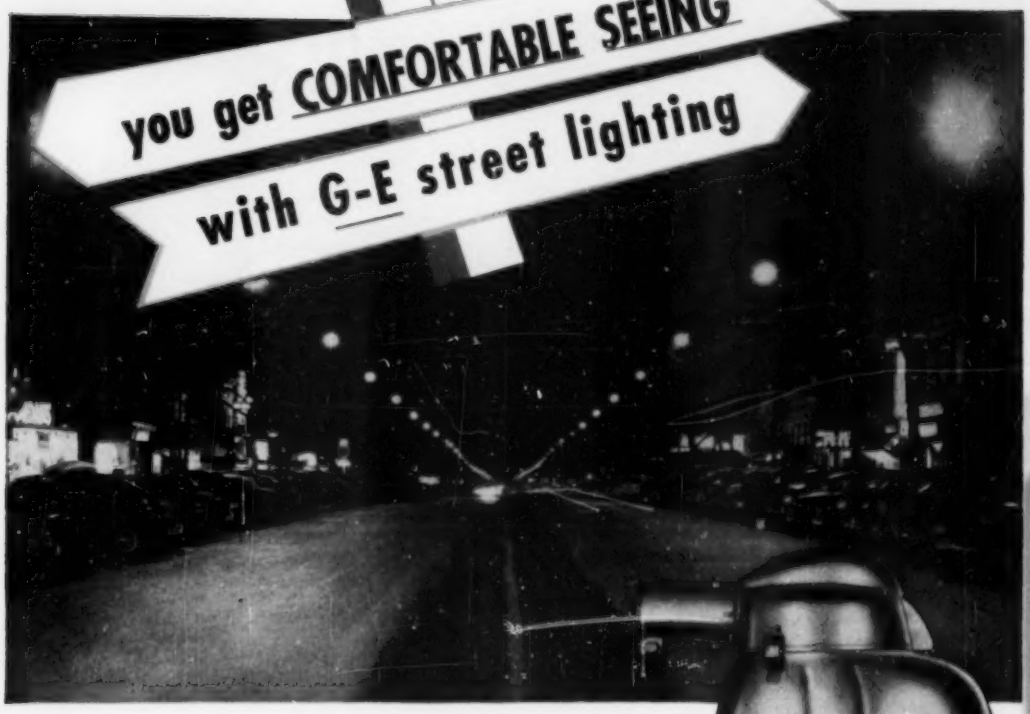
The SKYLIKE system combines the best features of silvered-bowl incandescent lighting with the architectural appeal of a fluorescent-type troffer. No other type of lighting has all its advantages! Here are some quick facts:

- Warm color—most desired by merchandising experts.
- High initial and maintained light output.
- Softly diffused shadows.
- Low brightness and 90° shielding.
- No flickering, blinking, or hum.
- Instant starting.
- Variable lamp size—150- to 500-watt.
- No light loss from darkened walls or ceilings.
- Floor-service relamping—no ladders or scaffolds.
- Hermetically sealed silver reflecting surface.
- Units fit 24" x 24" ceiling tiles, fully or partly recessed, or surface-mounted, in rows or patterns.
- Easily converted, with simple accessory, for directional or accent lighting.
- Simple in construction; simple in wiring; free of ballasts, starters, transformers.
- Lightweight; low-cost supporting construction.
- 87% reflection factor, easily maintained by occasional wiping with a damp cloth.
- Low-cost! ½ to ⅓ the cost of equipment delivering comparable results.

SILVRAY

Skylike

Distributed by Graybar Electric Company



VINELAND, NEW JERSEY RELIGHTS

Here's Vineland, N. J., the first New Jersey community to have its entire business district lighted with cool, comfortable, money-saving mercury.

Twenty years ago, Vineland had the latest type of main-street lighting. But by 1945, city officials realized their community had outgrown this street lighting. So they initiated a comprehensive street-lighting survey. In 1948, several test installations of both incandescent and mercury were put up for public inspection. General Electric's new trendmaking Form 109—burning 15,000-lumen mercury lamps horizontally—won a hands-down decision. Now Vineland has Comfortable Seeing.

COMMUNITY IMPRESSED

The merchants are enthusiastic. Landis Avenue is proving an even greater mecca for shoppers. Citizens are proud of their main street. Police point to better traffic safety. Municipal engineers are proud of the soft, evenly distributed light cast all the way across the expansive 78-foot street. Altogether, Vineland is sold on their new street lighting—so sold that as soon as the lights went on, they immediately ordered more Form 109's to extend the Comfortable Seeing.

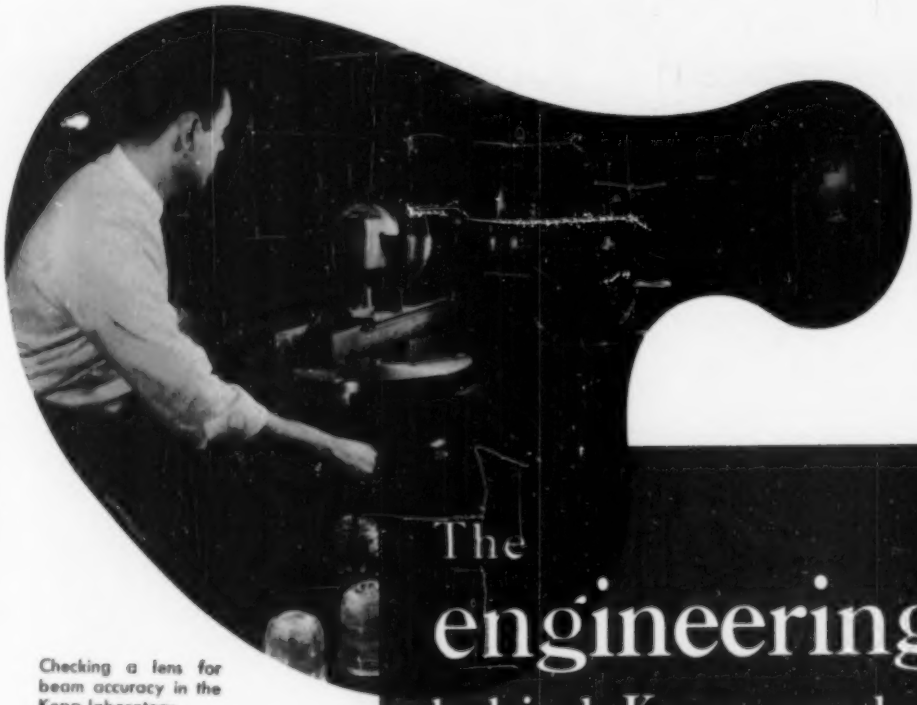
RELIGHT WITH COMFORTABLE SEEING

When you make your relighting plans, be sure to get business-stimulating, eye-easing COMFORTABLE SEEING. For your heavy-traffic streets, ask your utility or nearest G-E Apparatus Department lighting specialist to explain the details of the new Form 109. *Apparatus Department, General Electric Company, Schenectady 5, New York.*

*COMFORTABLE SEEING—the light you need, exactly where you need it, economically.

GENERAL ELECTRIC

452-122



Checking a lens for beam accuracy in the Kopp laboratory.

The engineering behind Kopp products brings the results you want

KOPP specializes in lighting glassware, engineered and made to meet your particular needs. Whether your requirements are for beam control, floodlighting, signal work or color transmission, Kopp can furnish lenses, filters, cover glasses and other glassware that is correctly engineered and well made.

In our modern laboratories, research work is conducted and sample products tested. Quality control methods assure the uniformity and accuracy of Kopp products.

Write for 24-page brochure describing Kopp Glassware.

Typical Kopp Beam-Control Lenses

KOPP GLASS

KOPP GLASS, INC., SWISSVALE, PA.

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MANUFACTURERS' REPRESENTATIVE AVAILABLE

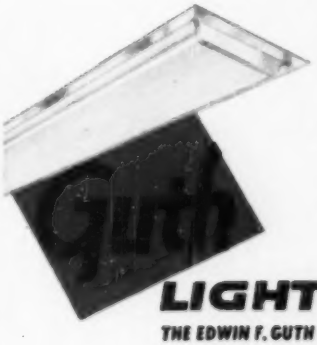
Manufacturers seeking representative for their products in New York State please write Joseph Sherr, 524 Clinton Ave., N., Rochester 5, N. Y.

GUTH LITE-BLOX

RECESSED TROFFERS because . . .

You can create with them an endless variety of efficient and aesthetic lighting patterns. It's simple: LITE-BLOX take the place of ceiling blocks.

- FAR MORE VERSATILE — 18 sizes all with same cross-section. 32 choices of standard and slimline fluorescent lamps. Wide range of diffusing and shielding media.
- FAR EASIER, CHEAPER TO INSTALL — One-man can hang them with QM Brackets. Complete units ready to mount — no joiners. Exact footlengths — no trimming.
- PLUS THAT "HAND-CRAFTED" LOOK — Snap-on tailored trim in choice of smart plated finishes gives costly "custom-made" appearance — at stock prices!



Build Your Relighting Plans With LITE-BLOX

For full details call your nearest GUTH resident engineer or write today for Bulletin 869-I.

LIGHTING

THE EDWIN F. GUTH COMPANY / ST. LOUIS 3, MISSOURI

Leaders in Lighting Since 1902

In Lone Star's Reception Room
rem 3 [illegible] x 8' panels of white translucent PLEXIGLAS are mounted 12" below twenty 30-watt, 36" fluorescent lamps, spaced on 16" centers. Average illumination 55 foot candles. Design and installation by The Frink Corp., Long Island City, N. Y. Architects: Kenneth H. Ripnen Inc., New York City. Lighting Consultant: E. B. Silverman, Smith & Silverman, New York City.

Lone Star's Board of Directors' Room

Lone Star's Executive Offices

Skylighted Office? No! It's a PLEXIGLAS Luminous Fixture

Man-made daylight—soft, even, glare-free—is a functional and decorative feature of Lone Star Cement Company's new offices in New York City. In nearly every room, PLEXIGLAS Luminous Ceilings diffuse light so perfectly that a *luminous environment* is created, easy on the eyes and nerves.

PLEXIGLAS simplifies the design, installation and maintenance of other lighting fixtures, too. Because this acrylic plastic is easily cut, shaped and fabricated, it adapts readily to coffer, cove or trough lighting, completely enclosed units, wall or overhead lighting of all kinds. Lightness and strength make it easy and inexpensive to ship and erect. Resistance to breakage and discoloration cuts maintenance costs to a minimum.

Get Full Details Today. Free information on PLEXIGLAS Quality Lighting for offices, homes, stores, drafting rooms, public buildings, is yours for the asking. Send for our new brochure, No. 77, "As Light as Day the PLEXIGLAS Way," and tell us about your lighting problem. The counsel of our Design and Fabrication Laboratory Staff is yours without obligation.

PLEXIGLAS *is a trade-mark, Reg. U. S. Pat. Off., and in principal foreign countries.*
Canadian Distributor: *Crystal Glass & Plastics, Ltd., 54 Duke Street, Toronto, Ontario, Canada*

CHEMI

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PROCEEDINGS

containing complete preprints of all technical papers presented at the I.E.S. National Technical Conference, Pasadena, Calif., August 21 through 24, 1950.

Since it is probable that all of the Conference papers will not be published in full in ILLUMINATING ENGINEERING, this volume has been prepared for those Society members and others who wish the complete presentation for record or reference purposes.

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PERFORMANCE THAT ASSURES BETTER LIGHT

Acme Electric ballasts have been engineered to eliminate "strobe" effect, provide more lumen output, longer lamp life, quiet operation. Their better performance assure your customer's satisfaction.

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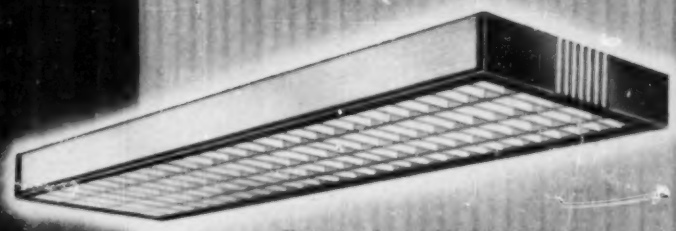
TRANSFORMERS

MATERIAL QUALITY CONTROL FOR LIGHT DISTRIBUTION CONTROL



The testing of material for light transmission, diffusion and reflectance characteristics is a contributing factor in the advance design of Sunbeam fixtures. This provides the architect and lighting consultant with an extensive choice of fixture configurations and specific types of light distribution. Sunbeam's 1710 series, with 4 variations of shielding elements, is typical of this design approach. These units are supplied with glass or metal side panels and with metal egg-crate louver or glass bottom. Each produces a lighting quality to meet specific needs. The 1710 series may be ceiling or pendant mounted and is available in all standard fluorescent and slimline lamp lengths and milliamp ratings. See your leading electrical distributor for further information.

SUNBEAM
LIGHTING CO., 777 E. 14TH PLACE
LOS ANGELES 21, CALIFORNIA

Now Instant Start Fluorescent Home Lighting

Here's the secret of "trigger-start" ballasts: Special windings in the ballast are used for instantaneously pre-heating the lamp cathodes. As a result, the ballast's open circuit voltage becomes sufficient to strike the arc. ***Starters are completely eliminated!***

with GE "trigger-start" ballasts

Here is instant starting for standard fluorescent lamps in residential-type fixtures. And it is accomplished merely by using a unique new ballast. With General Electric's revolutionary "trigger-start" ballast, any standard 20-watt lamp or any standard 32-watt Circline lamp starts with a flick of the switch.

These "trigger-start" ballasts are listed by Underwriters Laboratories, are exceptionally quiet in operation, and have the characteristic dependability that has made G-E ballasts "the brand in biggest demand." G-E ballasts make any fixture a better fixture. So, when you're specifying or buying fluorescent fixtures—or replacement ballasts—insist on General Electric "trigger-start" ballasts. *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

This label on a fixture carton, or the familiar G-E ballast tag on a fixture, is your assurance of fine ballast performance. Buy—when you see the G-E ballast label or tag.
Ballast
GENERAL ELECTRIC

GENERAL ELECTRIC

PROTECT YOURSELF WITH . . .

CERTIFIED BALLASTS

CERTIFIED BALLASTS usually outlast the life of a fluorescent lighting installation.

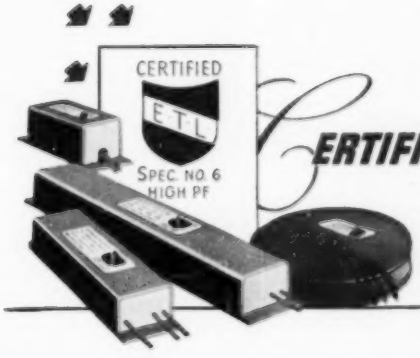
This assures customer satisfaction . . . protects you against complaints and costly replacements.

CERTIFIED BALLASTS have long, satisfactory life, assure rated light output and full lamp life because they are made to exacting specifications, then tested and checked by Electrical Testing Laboratories, Inc., an impartial authority.

You're protected when the fixtures you sell or install are equipped with **CERTIFIED BALLASTS!**

Complete information on the types of **CERTIFIED BALLASTS** available from each participating manufacturer may be obtained from Electrical Testing Laboratories, Inc., East End Avenue at 79th Street, New York, New York.

Participation in the CERTIFIED BALLAST program is open to any manufacturer who complies with the requirements of CERTIFIED BALLAST MANUFACTURERS.



CERTIFIED BALLAST MANUFACTURERS

Makers of Certified Ballasts for Fluorescent Lighting

2116 KEITH BLDG., CLEVELAND 15, OHIO

Patterns for Lighting Profits

See how Sylvania Trimline Fixtures conform to this store's arrangement ... brighten up all display and working areas.

Custom-fitted lighting for every prospect with Sylvania Trimline Fluorescent Fixtures and Trimspots.

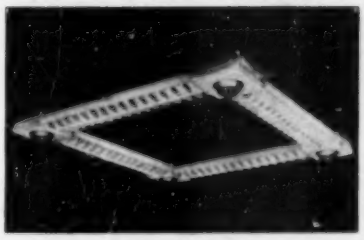
Now you can make interior lighting work *extra hard* for your customers ... mean extra profits for you!

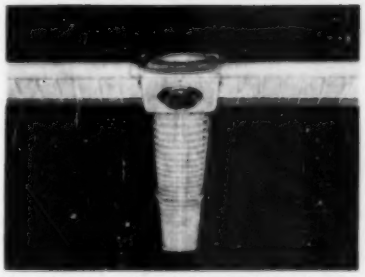
With flexible, Sylvania Fluorescent Trimline Fixtures and Trimspots, you can concentrate light exactly where it is needed most. You'll enable your customers to get maximum benefits from their lighting and also to enjoy attractive, well-balanced ceiling lighting patterns.

A complete line

Remember—the Sylvania Trimline series is a complete line. There are 13 handsome, white "Miracoated" fixtures in different sizes and types. Equipped with 2 or 4 Sylvania long-life fluorescent tubes ... standard or instant start ... louvered or fully plastic shielded.

On your next lighting layout ... large or small ... be sure to include Sylvania Trimline fixtures in your plans. With Trimline you're *in* line for more business ... more profits. New illustrated folder shows why. For your free copy, address: Sylvania Electric Products Inc., Dept. L-2912, 1740 Broadway, New York 19, N. Y.





Shown here are a few of the many different ceiling patterns now possible with Sylvania Trimline Fixtures and Trimspots.

SYLVANIA ELECTRIC

FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT; PHOTOLAMPS; TELEVISION SETS